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DEVELOPMENT DOCUMENT FOR EFFLUENT LIMITATIONS GUIDELINES AND NEW SOURCE PERFORMANCE STANDARDS FOR THE TEXTILE, FRICTION MATERIALS AND SEALING DEVICES SEGMENT OF THE ASBESTOS MANUFACTURING POINT SOURCE CATEGORY

ENVIRONMENTAL PROTECTION AGENCY

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Effluent limitations guidelines contained herein set forth the degree of effluent reduction attainable through application of best practicable control technology currently available and degree of effluent reduction attainable through application of best available technology economically achievable which must be achieved by existing point sources. The Standards of Performance for new sources contained herein set forth the degree of effluent reduction that is achievable. The development of data and recommendations in the document relate to a portion of the asbestos manufacturing category in which water usage is limited. Supportive data and rationale for development of the proposed effluent limitations guidelines and standards of performance are contained in this report.

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DEVELOPMENT DOCUMENT

for

EFFLUENT LIMITATIONS GUIDELINES

and

NEW SOURCE PERFORMANCE STANDARDS

for the

TEXTILE, FRICTION MATERIALS AND SEALING DEVICES SEGMENT OF THE ASBESTOS MANUFACTURING POINT SOURCE CATEGORY

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ABSTRACT

This document presents the findings of an extensive study of part of the asbestos manufacturing industry by the Environmental Protection Agency for the purpose of developing effluent limitations guidelines and Federal standards of performance, for the industry, to implement Sections 304, 306, and 307 of the "Act."

Effluent limitations guidelines contained herein set forth the degree of effluent reduction attainable through the application of the best practicable control technology currently available and the degree of effluent reduction attainable through the application of the best available technology economically achievable which must be achieved by existing point sources by July 1, 1977, and July 1, 1983, respectively. The Standards of Performance for new sources contained herein set forth the degree of effluent reduction that is achievable through the application of the best available demonstrated control technology, processes, operating methods, or other alternatives.

The development of data and recommendations in the document relate to a portion of the asbestos manufacturing category in which water usage is limited. This segment was subdivided into four subcategories on the bases of raw waste loads, quantities of waste water discharged, and applicability of control measures. Separate effluent limitations were developed for each subcategory on the bases of the level of raw waste loads as well as the degree of treatment achievable by suggested model systems. These systems include sedimentation (with coagulation, as necessary), neutralization, biological treatment, carbon adsorption, substitution of dry air pollution control equipment, and certain in-plant changes.

Supportive data and rationale for development of the proposed effluent limitations guidelines and standards of performance are contained in this report.

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SECTION I

CONCLUSIONS

That part of the asbestos industry covered in this document (Phase II) includes the manufacture of asbestos textiles, friction materials, and asbestos gaskets, packings, and sealing devices. In most of the plants in this part of the industry, water is not used in the manufacturing processes and waste waters are not generated. In a few plants, process-related waste waters are generated by manufacturing operations or by air pollution control equipment. The industry covered in this document is classified into four subcategories. The factors in this subcategorization were raw waste loads, volumes and rates of discharge of waste waters, and differences in applicable in-plant control measures and end-of-pipe treatment technologies.

The subcategories are for the following operations:

1. Coating, or finishing, of asbestos textiles,
2. Solvent recovery,
3. Vapor absorption, and
4. Wet dust collection.

The waste waters resulting from the first three subcategories are similar in that the primary pollutants are synthetic organic resins, elastomers, and/or solvents, but they differ in composition and concentration. The wastes from the wet dust collectors are characterized by high suspended solids levels.

About half of the plants that generate waste waters discharge to municipal sewerage systems, with or without pretreatment. The remaining plants provide at least lagoon sedimentation prior to discharge to surface waters. None of the plants included in this study provide treatment designed to remove dissolved organic pollutants.

Recommended effluent limitations to be achieved by July 1, 1977, and July 1, 1983, are summarized in Section II. It is estimated that the investment cost of achieving the 1977 limitations and standards by all plants in the industry is approximately $200,000, excluding costs of additional land acquisition. The cost of achieving the 1983 level is estimated to be less than $800,000 for the industry, i.e., an additional $600,000 over the 1977 level.

→ [illegible]

SECTION II

RECOMMENDATIONS

Recommended control and treatment technologies for this part of the asbestos industry were developed for each subcategory. The discharge of pollutants from asbestos textile coating to surface waters can be eliminated through in-plant measures; i.e., elimination of dumps and spills and substitution of dry cleaning techniques for wet clean-up methods. The discharge of organic pollutants from solvent recovery and vapor absorption operations can be reduced or eliminated by biological treatment, carbon adsorption, and/or substitution of dry air pollution control equipment. The discharge of suspended solids from wet particulate collectors can be controlled by sedimentation and eliminated by substituting dry dust collection devices for the wet scrubbers.

The recommended effluent limitations as 30-day averages for parameters of major significance and standards of performance for plants within the four subcategories are summarized as follows:

Best Practicable Control Technology Currently Available

	Textile Coating	Solvent Recovery*	Vapor Absorption	Wet Dust Collection**
COD	zero	0.150	zero	NA
Suspended Solids	zero	0.090	zero	2.50
pH	- -	6-9	6-9	6-9

Best Available Technology Economically Achievable

	Textile Coating	Solvent Recovery*	Vapor Absorption	Wet Dust Collection
COD	zero	0.150	zero	zero
Suspended Solids	zero	0.090	zero	zero
pH	- -	6-9	- -	- -

Standards of Performance for New Sources

	Textile Coating	Solvent Recovery*	Vapor Absorption	Wet Dust Collection
COD	zero	0.150	zero	zero
Suspended Solids	zero	0.090	zero	zero
pH	- -	6-9	- -	- -

*COD and SS as lb/1000 of finished asbestos products.
**NA - Not Applicable. SS as lb/MM std cu ft of air scrubbed.

Preceding page blank

More detailed explanations of these limitations are presented in Sections IX, X, and XI of this document.

SECTION III

INTRODUCTION

PURPOSE AND AUTHORITY

Section 301(b) of the Act requires the achievement by not later than July 1, 1977, of effluent limitations for point sources, other than publicly owned treatment works, which are based on the application of the best practicable control technology currently available as identified by the Administrator pursuant to Section 304(b) of the Act. Section 301(b) also requires the achievement by not later than July 1, 1983, of effluent limitations for point sources, other than publicly owned treatment works, which are based on the application of the best available technology economically achievable which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants, as determined in accordance with regulations issued by the Administrator pursuant to Section 304(b) of the Act. Section 306 of the Act requires the achievement by new sources of a Federal standard of performance providing for the control of the discharge of pollutants which reflects the greatest degree of effluent reduction which the Administration determines to be achievable through the application of the best available demonstrated control technology, processes, operating methods, or other alternatives, including, where practicable, a standard permitting no discharge of pollutants.

Section 304(b) of the Act requires the Administrator to publish within one year of enactment of the Act, regulations providing guidelines for effluent limitations setting forth the degree of effluent reduction attainable through the application of the best practicable control technology currently available and the degree of effluent reduction attainable through the application of the best control measures and practices economically achievable including treatment techniques, process and procedure innovations, operation methods and other alternatives. The regulations proposed herein set forth effluent limitations guidelines pursuant to Section 304(b) of the Act for certain subcategories of the asbestos manufacturing source category, relating to textiles, friction materials, and sealant devices. They include coating of textile products, solvent recovery, vapor absorption, and wet dust collection.

Section 306 of the Act requires the Administrator, within one year after a category of sources is included in a list published pursuant to Section 306(b)(1)(A) of the Act, to propose regulations establishing Federal standards of performance for new sources within such categories. The Administrator published in the Federal Register of January 16, 1973 (38 F.R. 1624), a list of 27 source categories. Publication of the list constituted announcement of the Administrator's intention of establishing, under Section 306, standards of performance applicable to new sources within the asbestos manufacturing industry subcategory as delineated above, which was included with the list published January 16, 1973.

SUMMARY OF METHODS USED FOR DEVELOPMENT OF THE EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS OF PERFORMANCE

Purpose and Authority

The effluent limitations guidelines and standards of performance proposed herein were developed in the following manner. The point source category was first categorized for the purpose of determining whether separate limitations and standards are appropriate for different segments within a point source category. Such subcategorization was based upon raw material used, product produced, manufacturing process employed, and other factors. The raw waste characteristics for each subcategory were then identified. This included an analysis of (1) the source and volume of water used in the process employed and the sources of waste and waste water in the plant; and (2) the constituents (including thermal) of all waste waters; including toxic constituents and other constituents which result in taste, odor, and color in water or aquatic organisms. The constituents of waste waters which should be subject to effluent limitations guidelines and standards of performance were identified.

The full range of control and treatment technologies existing within each subcategory was identified. This included an identification of each distinct control and treatment technology, including both in-plant and end-of-process technologies, which are existent or capable of being designed for each subcategory. It also included an identification in terms of the amount of constituents (including thermal) and the chemical, physical, and biological characteristics of pollutants, of the effluent level resulting from the application of each of the treatment and control technologies. The problems, limitations and reliability of each treatment and control technology and the required implementation time was also identified. In addition, the non-water quality environmental impact, such as the effects of the application of such technologies upon other pollution problems, including air, solid waste, noise and radiation were also identified. The energy requirements of each of the control and treatment technologies were identified as well as the cost of the application of such technologies.

The information, as outlined above, was then evaluated in order to determine what levels of technology constituted the "best practicable control technology currently available," "best available technology economically achievable," and the "best available demonstrated control technology, processes, operating methods, or other alternatives." In identifying such technologies, various factors were considered. These included the total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application, the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques process changes, non-water quality environmental impact (including energy requirements) and other factors.

Sources of Data

The waste waters associated with asbestos manufacturing have received almost no attention in the engineering and pollution control literature. Very few plants have collected any extensive data about the characteristics of the waste waters discharged. The information used in this document was derived from a number of sources. Some of the sources were published literature on manufacturing methods, EPA technical reports on the industry, and consultation with qualified personnel. Additional information was obtained from plant visits; plant records, where available; and from the few RAPP applications that have been filed. Most of the information was developed through direct contact by the EPA contractor, with some additional material derived from a preliminary questionnaire distributed to its membership by the Fluid Sealing Association (formerly the Mechanical Packing Association).

Thirty-six companies or corporations at 51 plant locations in the United States provided information for this document. Another thirteen companies, exclusive of those receiving the questionnaire distributed by FSA, were contacted and found not to be manufacturers of products covered by this study. The 36 companies include most of the large- and medium-sized manufacturers and what is believed to be a representative cross-section of the small organizations.

The products covered by this study can be grouped into three types as shown below. The 51 plants included in this study are distributed among the product types as follows:

Asbestos Textile Products	10 plants
Friction Materials	25
Asbestos-Containing Gaskets, Packings, and Sealing Devices	11
Multi-Products Plants	5

At three of the multi-product plants, two Phase II product types are manufactured. All three Phase II product types are made at two plants. In addition, at ten of the 51 plants, non-Phase II products are also manufactured. At three of these locations, the other products are asbestos items covered in the Phase I study. At the remaining seven plants, non-asbestos product manufacturing generates waste waters that are much more significant in terms of quantities and types of pollutant constituents. The wastes from asbestos manufacturing are combined with these stronger wastes for treatment and/or discharge. The combined effluents should be regulated by the guidelines developed for the other non-asbestos products.

As noted above, a voluntary questionnaire was distributed to those members of the FSA not contacted directly by the EPA contractor. The questionnaire was distributed in order to locate for further study those asbestos-containing sealant manufacturing plants that discharge process waste waters. It also provided an opportunity for companies that were not contacted directly to participate in the study, if they wished. A copy of this preliminary questionnaire is presented on the following pages. All manufacturers of asbestos-containing sealing devices that completed and returned the questionnaire indicated that no process waste waters are generated in their operations.

Of the 28 questionnaires distributed, eight were returned. This return of close to 30 percent is believed to be reasonably successful in light of the fact that many members of the FSA manufacture non-asbestos sealing devices and, hence, would have little incentive to return the questionnaire.

GENERAL DESCRIPTION OF THE INDUSTRY

Although known as a curiosity since biblical times, asbestos was not used in manufacturing until the latter half of the 19th century. By the early years of the 20th century, much of the basic technology had been developed, and the industry has grown in this country since about that time. Canada is the world's largest producer of asbestos, with the USSR and a few African countries as major suppliers. Mines in four states: Arizona, California, North Carolina, and Vermont, provide a relatively small proportion of the world's supply.

Asbestos is normally combined with other materials in manufactured products, and consequently, it loses its identity. It is a natural mineral fiber which is very strong and flexible and resistant to breakdown under adverse conditions, especially high temperatures. One or more of these properties are exploited in the various manufactured products that contain asbestos.

Asbestos is actually a group name that refers to several serpentine minerals having different chemical compositions, but similar characteristics. The most widely used variety is chrysolite. Asbestos fibers are graded on the basis of length, with the longest grade priced 10 to 20 times higher than the short grades.

QUESTIONNAIRE FORM

Company Name ____

Plant Address ____

Name of Contact at Plant ______________________________

Telephone Number at Plant ______________________________

Product(s) Manufactured ________________________________

Operating Schedule: _______ Hours per Day _______ Days per Week

Number of Employees _______

Are there other plants in this company that manufacture asbestos-containing products? Yes _____ No _____

1. Do any of the products manufactured or fabricated at this plant contain asbestos? Yes _____ No _____
   If "no", please stop here and return questionnaire.
   If "yes", please continue below.

2. Is water used in any way in the manufacturing or auxiliary operations? Yes _____ No _____
   If "no", please stop here and return questionnaire.
   If "yes", please complete below.

3. Is any waste water (other than sanitary) discharged from plant? Yes _____ No _____

4. Is waste water treated before leaving plant property?
   Yes _____ No _____

5. Is waste water (with or without treatment) discharged to:
   public sewer ______
   stream or lake ______
   lagoon ______

   other (please describe) ______________________________

   ____

   ____

6. Is information available about the quantities of waste waters discharged? Yes _____ No _____
About the waste water characteristics? Yes _____ No _____
If "yes", please describe type of information:

____

____

____

7. Has a discharge permit application been filed for this plant?
Yes _____ No _____

On a world-wide basis, asbestos-cement products materials and pipe currently consume about 70 percent of the asbestos mined. In the United States in 1971, the consumption pattern was reported to be:

Vinyl-Asbestos Floor Tile	19.2%
Asbestos-Cement Pipe	18.7
Paper and Felt, including Roofing	14.7
Friction Materials	10.7
Asbestos-Cement Building Materials	6.7
Packing Materials	3.3
Textiles	2.9
Asbestos Insulation	2.1
Spray-on Asbestos Materials	2.0
All Other Asbestos Products	19.0
	100.0%

These figures do not accurately reflect the production levels of these products because the asbestos content varies from about 10 to almost 100 percent among the different manufactured products.

The asbestos manufacturing industry is classified in two SIC groups: 3292, Asbestos Products; and 3293, Gaskets, Packing and Sealing Devices. The products covered in the earlier Phase I study of this industry were:

Asbestos-Cement Products,
Asbestos Paper and Felt,
Asbestos Millboard,
Asbestos Roofing Products,
Asbestos Floor Tile, and
Asbestos Block Insulation.

This Phase II document includes the remaining products in these SIC groups. They may be grouped as follows:

Textile Products - yarn, cord, rope, thread, tape, wicks, and various fabrics.

Friction Materials - brake linings, clutch facings, and related items.

Gaskets, seals, washers, and packings that contain asbestos.

LOCATION OF MANUFACTURERS

The locations of the 51 plants that were contacted in connection with this study are listed in Table 1. This listing includes all of the known manufacturers of asbestos textiles, most of the plants engaged primarily in manufacturing friction materials, and what is believed to be a large, representative sampling of producers of asbestos-containing gaskets, packings, and sealing devices.

TABLE 1

LOCATIONS OF ASBESTOS MANUFACTURING PLANTS - PHASE II

State	City	Company	Products
Alabama	Prattville	Molded Industrial Friction Corp.	FM
California	Fullerton	Raybestos-Manhattan	FM
Connecticut	Stratford	Raybestos-Manhattan	*FM, S
Georgia	Hogansville	Uniroyal, Inc.	*T
Illinois	Glenwood	Jas. Walker Packing Company, Inc.	S
	Waukegan	Johns-Manville	*S
Indiana	Crawfordsville	Raybestos-Manhattan	FM
	Logansport	National Friction Products Corp.	FM
	New Castle	World Bestos Company	FM
	Warsaw	Gatke Corporation	FM
Kentucky	Danville	Royal Industries Brake Products	FM
Massachusetts	Lawrence	Auto Friction Corporation	FM
	North Brookfield	Gatke Corporation	FM, T, S
Michigan	Hartford	Auto Specialties Manufacturing Co.	FM
	Saginaw	General Motors Corporation	*FM
	St. Joseph	Auto Specialties Manufacturing Co.	FM
	Trenton	Chrysler Corporation	*FM
New Hampshire	Meredith	Amatex Corporation	T

TABLE 1 (cont)

LOCATIONS OF ASBESTOS MANUFACTURING PLANTS - PHASE II

State	City	Company	Products
New Jersey	Cranford	Chempro, Inc.	S
	Manville	Johns-Manville	*T
	Newark	Reddaway	FM
	New Brunswick	Metallo Gasket Company	S
	North Brunswick	Johns-Manville	S
	Patterson	Brassbestos Manufacturing Corp.	FM
	Trenton	Mercer Rubber Company	S
	Trenton	Thiokol Chemical Corporation	FM
New York	Green Island	Bendix Corporation	*FM
	Palmyra	Garlock, Inc.	T, S
North Carolina	Charlotte	H. K. Porter, Inc.	T
	Laurinberg	Johns-Manville	FM
	Marshville	Raybestos-Manhattan	T
Ohio	Boydsville	Wheeling Brake Block Mfrg. Company	FM
	Chagrin Falls	Hollow Center Packing Company, Inc.	S
	Dayton	General Motors	*FM
	Dayton	General Motors	*FM
	Paulding	Maremont Corporation	FM
Pennsylvania	Ambler	Nicolet	*T, S
	Manheim	Raybestos-Manhattan	FM, T, S
	Norristown	Amatex Corporation	T
	North Wales	Atlas Textile Company	T
	North Wales	Greene, Tweed & Company	S
	Philadelphia	Asten-Hill Manufacturing Company	T
	Ridgway	Carlisle Corporation	FM

TABLE 1 (cont)

LOCATIONS OF ASBESTOS MANUFACTURING PLANTS - PHASE II

State	City	Company	Products
South Carolina	Bennetsville	H. K. Porter, Inc.	T
	North Charleston	Raybestos-Manhattan	T
Tennessee	Cleveland	Bendix Corporation	FM
	New Port	Detroit Gasket & Manufacturing Co.	S
Texas	Houston	Lamons Metal Gasket Company	S
	Houston	Standco Industries	FM
	Houston	Standco Industries	S
Virginia	Winchester	Abex Corporation	FM

KEY: FM - Friction Materials
S - Sealants (Gaskets, Packings, etc.)
T - Textiles

*Waste waters from manufacture of products not covered by this study are more significant at these plants.

At only ten of the listed plants are process-associated waste waters generated, and at five of these the waste waters emanate only from wet air pollution control equipment. In most cases, the manufacture of the products in this study is a "dry" process and does not result in the generation of process waste waters.

MANUFACTURING PROCESSES

The basic manufacturing processes for the products in the three groups covered are outlined below with sources of waste waters indicated. As noted previously, water is not normally used directly in the manufacturing operations, and the waste waters from this segment of the asbestos industry are generated in a few special operations not common to the industry generally.

TEXTILE PRODUCTS

The primary reasons for the use of asbestos fiber in textile products are its properties of durability and resistance to heat, fire, and acid. Asbestos is the only mineral that can be manufactured into textiles using looms and other textile equipment. The asbestos textile products are primarily used for friction materials, industrial packing, electrical insulation, and thermal insulation.

Figure 1 illustrates the steps in the manufacture of the various asbestos textile products. The textile plants receive the asbestos fiber by railcar in 100-pound bags. The bags are opened, and the fibers passed over vibrating screens or trommel screens for cleaning. The fibers are lifted from the screens by air suction and graded. After preparation, the fiber is mixed and blended. Chrysolite is the predominant fiber used in textiles. Crocidolite and amosite asbestos fibers may also be added to the chrysolite. Small percentages of cotton, rayon, and other natural or synthetic fibers serve as carriers or supports for the shorter asbestos fibers, and they improve the spinnability of the fiber mixture. Typically, the organic fiber content is between 20 and 25 percent. The blending and mixing operations are primarily done during carding of the fibers, but can also be performed in multi-hopper blending units.

In the carding operation, the fibers are arranged by thousands of needle-pointed wires that cover the cylinders of the carding machine. The fibers are combed by passing between the carding machine main cylinder and the worker cylinders rotating in the opposite direction. The carding machine forms a continuous mat of material. The mat is divided into strips, or slivers, and mechanically compressed between oscillating surfaces into untwisted strands. The strands are wound on spools to form the roving. Roving is the asbestos textile product from which asbestos yarn is produced.

The roving is spun into yarn in a manner similar to that employed to manufacture cotton and wool yarns. The strands of roving are converted into a single yarn by the twisting and pulling operations of a spinning machine. The yarn produced by spinning and twisting

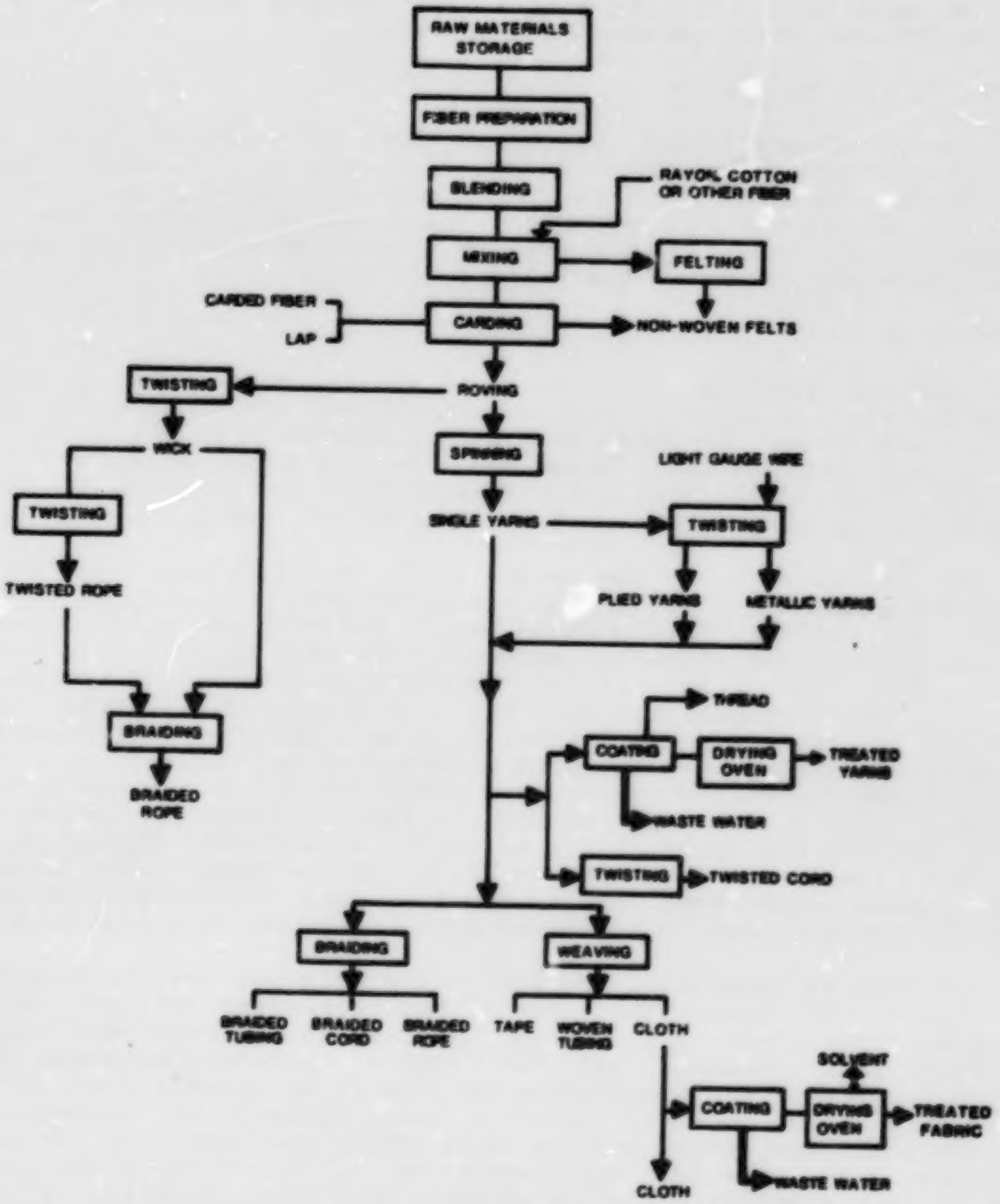
RAW MATERIALS STORAGE
FIBER PREPARATION
BLENDING
RAYON, COTTON OR OTHER FIBER
MIXING
FELTING
CARDED FIBER
LAP
CARDING
NON-WOVEN FELTS
TWISTING
ROVING
WICK
SPINNING
LIGHT GAUGE WIRE
TWISTING
SINGLE YARNS
TWISTING
TWISTED ROPE
PLIED YARNS
METALLIC YARNS
BRAIDING
BRAIDED ROPE
THREAD
COATING
DRYING OVEN
TREATED YARNS
WASTE WATER
TWISTING
TWISTED CORD
BRAIDING
WEAVING
BRAIDED TUBING
BRAIDED CORD
BRAIDED ROPE
TAPE
WOVEN TUBING
CLOTH
SOLVENT
COATING
DRYING OVEN
TREATED FABRIC
CLOTH
WASTE WATER

FIGURE 1-ASBESTOS TEXTILE MANUFACTURING OPERATIONS
(From handbook of Asbestos Textiles)

is the basic component of several other asbestos textile products. Asbestos twine or cord is produced by twisting together two or more yarns on a spinning frame similar to those used to manufacture cotton cord. Braided products are made by a series of yarn-carrying spindles, half traveling in one direction and half in the opposite direction to plait the yarn together and form a braided product.

Asbestos yarn can also be twisted or braided into various shapes to form packing and gaskets. The braided material can be impregnated with different compounds. Graphite is commonly used to impregnate braided packing material, the graphite serves to lower the frictional and binding properties of the packing.

Asbestos cloth is woven from yarn on looms that operate in a manner similar to those used for the manufacture of other textile products. The warp yarn is threaded through the heddles and the reed of the loom and the filler yarn is wound on quills and placed in a shuttle. The cloth is woven as the filler yarn in the shuttle interweaves the warp yarn transversely. Following weaving, the asbestos cloth is inspected for strength, weight, and asbestos content.

Asbestos yarn or cloth may be coated for fabrication into friction materials and special textile products. The material is drawn through one or more dip tanks and the coating material is spread by rollers, brushes, or doctor blades. The coated textile product then passes through a drying oven where the solvent is evaporated.

Water Usage

Water is not normally used in an asbestos textile manufacturing plant. Two exceptions are the addition of moisture during weaving or braiding and the coating operations. Waste water is generated only in the latter process.

Operating Schedule

A typical asbestos textile plant operates two or three shifts per day and five days per week.

FRICTION MATERIALS

Molded Products

The manufacturing steps typically used in dry-mix molded brake lining manufacture are shown in Figure 2. The bonding agents, metallic constituents, asbestos fibers, and additives are weighed and mixed in a two-stage mixer. The mix is then hand-tamped into a metal mold. The mold is placed in a preforming press which partially cures the molded asbestos sheet. The asbestos sheet is taken from the preforming press, and put in a steam preheating mold to soften the resin in the molded sheet. The molded sheet is formed to the proper arc by a steam-heated arc former, which resets the resin. The arc-formed sheets are then cut to the proper size. The lining is then baked in compression molds to retain the arc shape and convert the resin to a thermoset or permanent condition. The lining is then finished and, after inspection, is packaged. The finishing steps include sanding and grinding of both sides to correct the thickness, edge grinding, and drilling of holes for rivets. Following drilling, the lining is vacuum-cleaned, inspected, branded, and packaged.

Figure 3 shows the major steps in the manufacture of wet-mixed molded brake linings. The name "wet mix" process is a misnomer and refers to the use of a solvent. The ingredients of the molded lining are actually relatively dry. After weighing, they are mixed in a sigma blade mixer. The mixed ingredients are then sent to grinding screens where the particle size of the mixture is corrected. The mixture is conveyed to a hopper and is forced from the hopper into the nip of two form rollers which compress the mixture into a continuous strip of friction material. The strip is cut into the proper lengths and then arc-formed on a round press bar. The cutting and arc forming operations are done by separate units. The linings are then placed in racks and either air-dried or oven-dried to remove the solvent. An alternative process is to place the arc-formed linings in metal molds for baking in an oven. From the ovens, the linings are finished, inspected, and packaged.

Molded clutch facings are produced in a manner similar to the wet-mixed process. The rubber friction compound, solvent, and asbestos fibers are introduced into a mixer churn. After the churn mixes the ingredients, the mixture is conveyed to a sheeter mill which forms a sheet or slab of the materials. The sheet is then diced into small pieces by a rotary cutter. The pieces are placed in an extrusion machine which forms sheets of the diced material. The sheets are cut into the proper size and then punch-pressed into doughnut-shaped sheets. The scraps from the punch press are returned to the extrusion machine. The punched sheets are placed on racks and sent to a drying oven and then a baking oven for final curing and solvent evaporation. The oven-dried sheets are finally sent to the finishing operations. Figure 4 illustrates the steps in the manufacture of molded clutch facings.

Woven Products

Woven clutch facings and brake linings are manufactured of high-strength asbestos fabric that is frequently reinforced with wire. The fabric is predried in an oven or by an autoclave to prepare it to be impregnated with resin. The fabric can be impregnated with resin by several techniques: 1) immersion in a bath of resin, 2) introducing the binder in an autoclave under pressure, 3) introducing dry impregnating material into carded fiber before producing yarn, and 4) imparting binder into the fabric from the surface of a roll. After the solvents are evaporated from the fabric, it is made into brake linings or clutch facings. Brake linings are made by calendering or hot pressing the fabric in molds. The linings are then cut, rough ground, placed in molds, and placed in a baking oven for final curing. Following curing, the lining is finished, inspected, and packaged. The composition by weight of

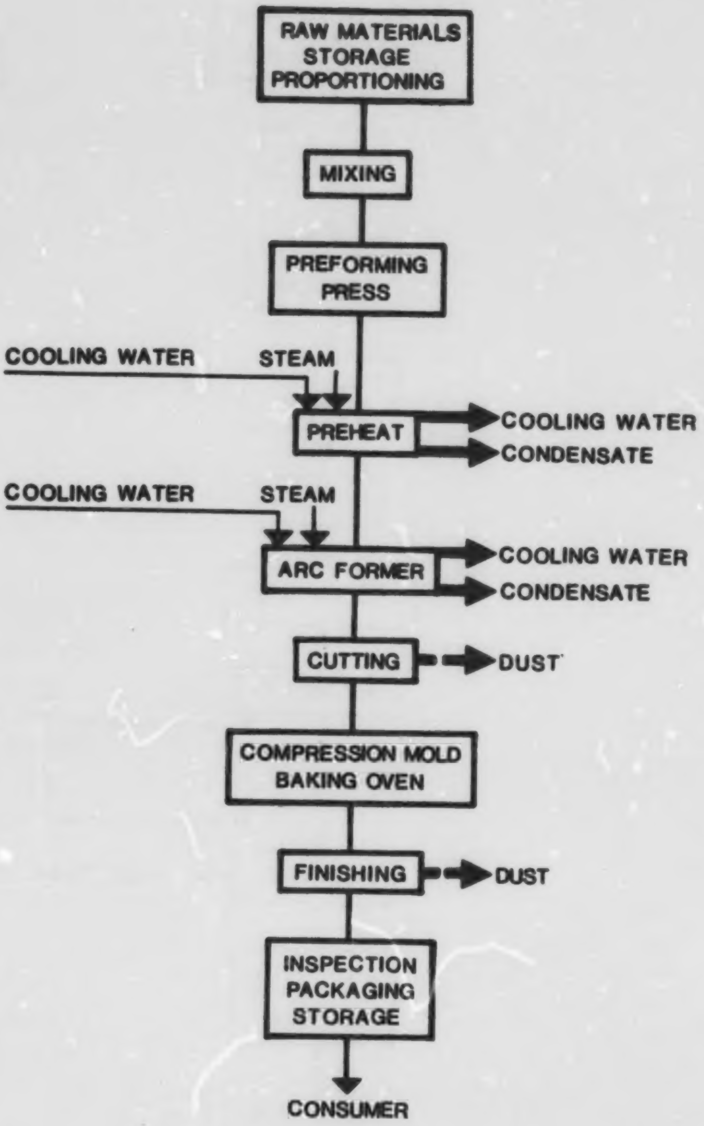
RAW MATERIALS STORAGE PROPORTIONING
MIXING
PREFORMING PRESS
COOLING WATER
STEAM
PREHEAT
COOLING WATER
CONDENSATE
COOLING WATER
STEAM
ARC FORMER
COOLING WATER
CONDENSATE
CUTTING
DUST
COMPRESSION MOLD BAKING OVEN
FINISHING
DUST
INSPECTION PACKAGING STORAGE
CONSUMER

FIGURE 2 - DRY-MIXED BRAKE LINING MANUFACTURING OPERATIONS

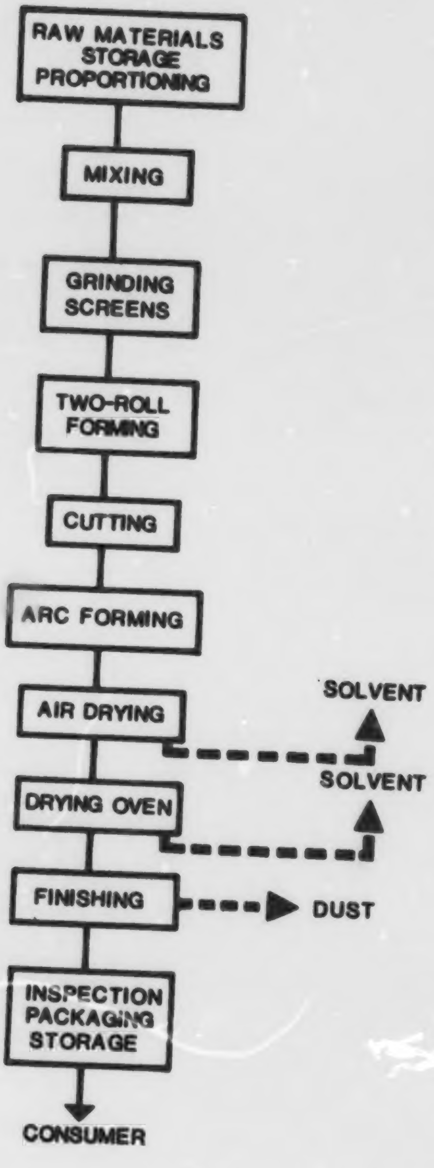
RAW MATERIALS
STORAGE
PROPORTIONING
MIXING
GRINDING
SCREENS
TWO-ROLL
FORMING
CUTTING
ARC FORMING
AIR DRYING
SOLVENT
DRYING OVEN
SOLVENT
FINISHING
DUST
INSPECTION
PACKAGING
STORAGE
CONSUMER

FIGURE 3 - WET-MIXED MOLDED BRAKE LINING MANUFACTURING OPERATIONS

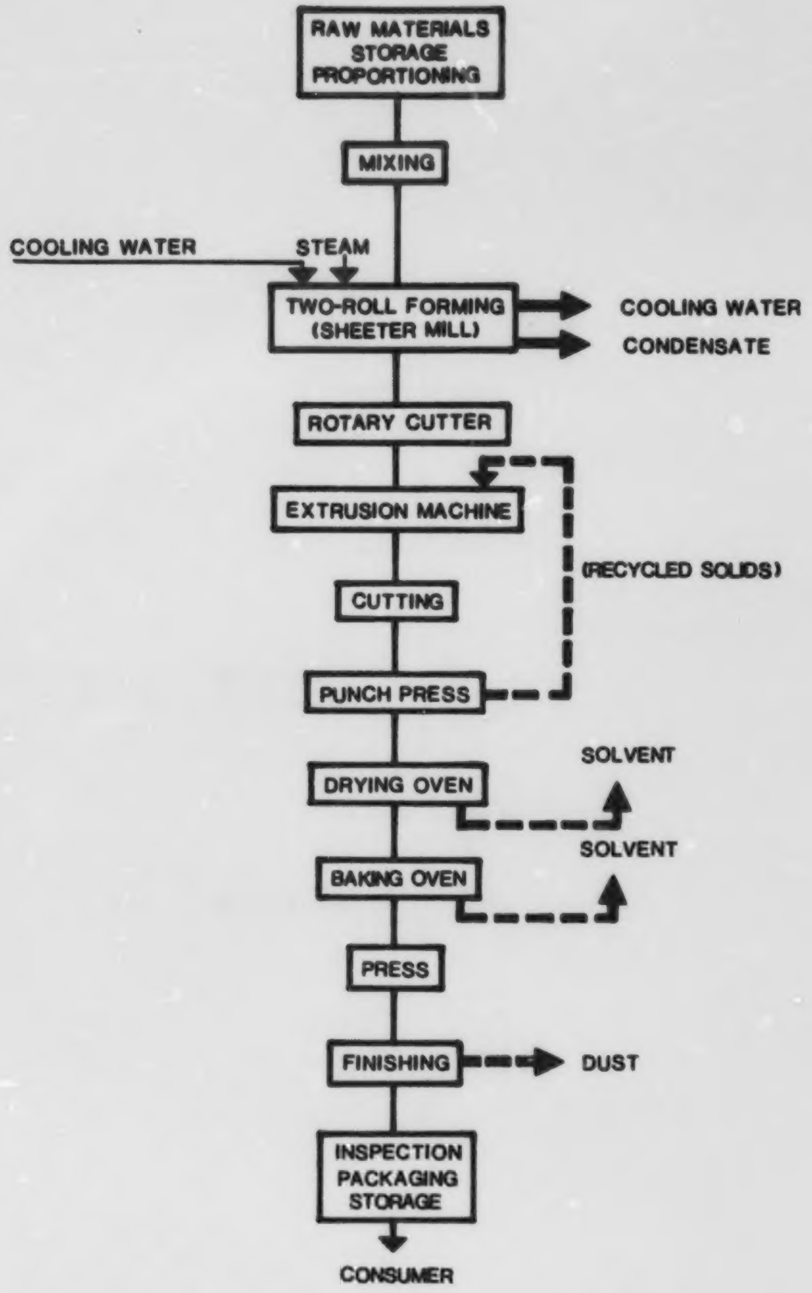
RAW MATERIALS STORAGE PROPORTIONING
MIXING
COOLING WATER
STEAM
TWO-ROLL FORMING (SHEETER MILL)
COOLING WATER
CONDENSATE
ROTARY CUTTER
EXTRUSION MACHINE
(RECYCLED SOLIDS)
CUTTING
PUNCH PRESS
SOLVENT
DRYING OVEN
SOLVENT
BAKING OVEN
PRESS
FINISHING
DUST
INSPECTION PACKAGING STORAGE
CONSUMER

FIGURE 4 - MOLDED CLUTCH FACINGS MANUFACTURING OPERATIONS

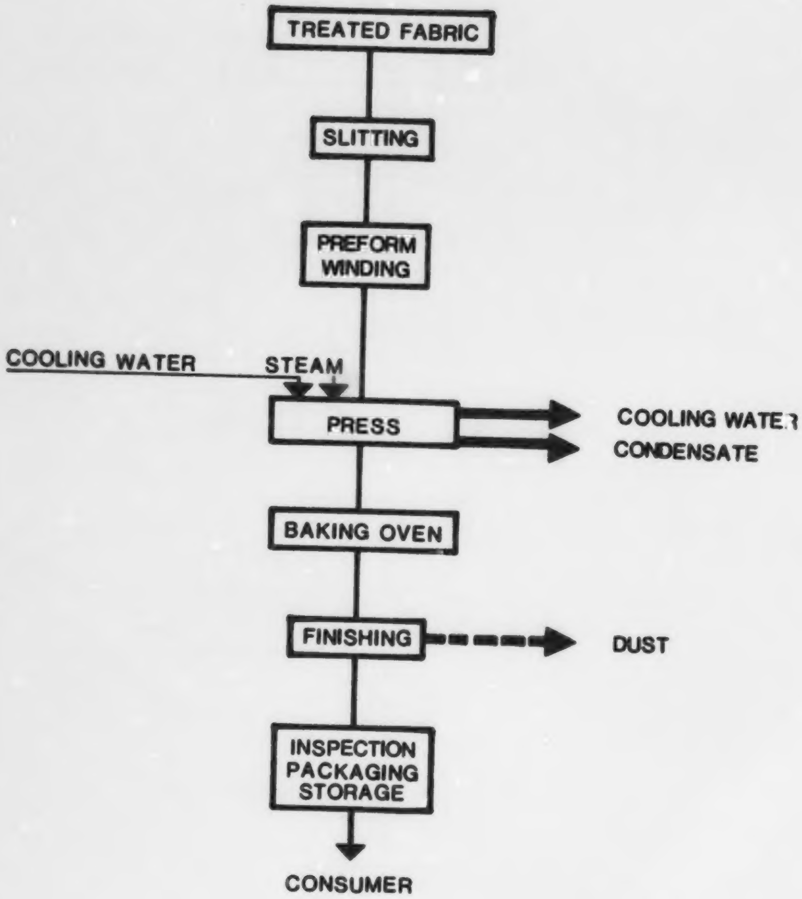
TREATED FABRIC
SLITTING
PREFORM WINDING
COOLING WATER
STEAM
PRESS
COOLING WATER
CONDENSATE
BAKING OVEN
FINISHING
DUST
INSPECTION PACKAGING STORAGE
CONSUMER

FIGURE 5 - WOVEN CLUTCH FACINGS MANUFACTURING OPERATIONS

woven brake linings ranges from 40 to 60 percent asbestos, 10 to 20 percent cotton, 20 to 40 percent wire, and 5 to 20 percent binder.

Figure 5 illustrates the manufacture of woven clutch facings. The treated fabric is cut into tape-width strips by a slitting machine. The strips are wound around a mandrel to form a roll of the fabric. The roll is pressed in a steam-heated press and then baked in an oven to cure the resin in the clutch facing. Following curing, the clutch facing is finished, inspected, and packaged.

Water Usage

Water does not mix with the ingredients of friction materials and is not used in the manufacturing processes. Waste waters are generated in a few friction materials plants in solvent recovery operations and in wet dust collection equipment used to control the quality of the air from the finishing areas. Most plants in this industry use dry dust collection equipment.

Operating Schedule

Friction materials plants typically operate two or three shifts a day on a five- or six-day per week schedule.

GASKETS, PACKING, AND SEALING DEVICES

The gaskets, packings, and sealing devices group includes a wide variety of products, many of which contain metallic components. The asbestos content of these products varies widely from one type to another. The typical plant making these products is a fabricator rather than a manufacturer, purchasing materials that are ready for cutting and assembly. There are many specialized hand operations in some plants in this category. Gaskets and packings may be made from asbestos paper, felt, and millboard; yarn, cloth, wick, and rope; and sheet gasket material. The waste waters associated with asbestos paper, felt, and millboard were covered in the Phase I document.

The variety of materials and forms comprising this group of products is so wide that it precludes general descriptions of typical manufacturing processes.

Water Usage

In this study, no plant was found that used water in the manufacture of gaskets, packing, and/or sealing devices. The manufacture of sheet gasket material may involve cooling and solvent recovery operations that produce waste waters. Among the plants contacted in this study, only one was found that generated waste water from a sheet gasket production facility, and this was from the solvent recovery operations.

In summary, the fabrication of asbestos-containing gaskets, packings, and sealing devices does not normally result in process waste waters, although the manufacture of some of the raw materials may result in process-associated wastes.

Operating Schedule

Sealant manufacturing plants normally operate one or two shifts for five days a week.

CURRENT STATUS OF THE INDUSTRY

There has long been concern about the industrial hygiene aspects of the dust and fiber emitted to the air in the asbestos manufacturing industry. Asbestos was among the first materials to be declared a hazardous air pollutant under the Clean Air Act Amendment of 1970. Some of the waste waters generated in this portion of the asbestos industry result in part from measures to eliminate or reduce the hazards. Asbestos textiles are coated to make them safer during fabrication and when used by the consumer.

The most significant effect of the recently increased concern about asbestos is the trend toward substitution of other materials, especially among users of textile products. New uses and markets for asbestos will be more difficult to develop in the future unless means are found to reduce the potential hazards. Despite the declines in some areas, however, the unique characteristics of asbestos plus new developments within the industry make the outlook for future growth favorable in the textile, friction materials, and sealant manufacturing segments of the industry.

SECTION IV

INDUSTRY CATEGORIZATION

INTRODUCTION

In developing effluent limitations guidelines and standards of performance for new sources for a given industry, a judgment was made by EPA as to whether different effluent limitations and standards were appropriate for different subcategories within the industry. In the final analysis, the underlying distinctions between the various subcategories are based on the methods of air pollution control, solvents recovery and resulting waste water characteristics. The factors considered in determining whether such subcategories were justified for this part of the asbestos manufacturing industry were:

1. Product,
2. Raw Materials,
3. Manufacturing Process,
4. Characteristics and Treatability of Waste Waters,
5. Air Pollution Control Equipment,
6. Plant Size,
7. Plant Age, and
8. Geographic Location.

Based on review of the literature, plant visits and interviews, and consultation with industry representatives, the above factors were evaluated and it was concluded that this part of the asbestos manufacturing industry (Phase II) should be divided into four subcategories:

1. Coating, or finishing, of asbestos textiles,
2. Solvent recovery operations,
3. Vapor absorption equipment (fume scrubber), and
4. Wet particulate (dust) collectors.

In addition to the above, it should be noted that there is a potential source of waste water in this part of the asbestos industry; namely, the manufacture of yarn by the dispersion process. At the time of this study, two plants in the country have pilot-plant or experimental manufacturing operations using this process. The level of production is extremely limited today, but it could increase in the future. While these operations are too limited to be considered in this study, it was determined that, even with in-plant controls, the associated waste waters can be expected to contain both organic and inorganic pollutants. If this process becomes operational, separate effluent limitations guidelines might be developed, if required.

FACTORS CONSIDERED

Product

The products included in this segment of the asbestos industry cover a wide range of manufactured items and materials, many of which are related only in that they contain asbestos fibers. Textiles are manufactured into many special-use articles and are also converted into friction materials and sealing devices. Some plants consume all of their textile production in manufacturing brake linings, clutch facings, and other friction products. Non-fabric friction materials and gaskets are also produced in large quantities, in some cases, in the same plants manufacturing textile-based counterparts. In sum, categorization by product would tend to confuse, rather than clarify, understanding and analysis of the industry.

Raw Materials

Many raw materials are used in this industry and most have a marked influence on the nature and treatability of the wastes. However, because of the small number of waste water sources, categorization in terms of raw materials is not useful. In other words, where the raw materials result in distinctive differences in the wastes, the individual plants are not similar. Categorization based on raw materials would result in several categories with only one plant in each.

Manufacturing Process

Within this industry, there are two fully developed manufacturing processes that may result in the generation of waste waters. One is the coating of asbestos textiles to be made into industrial belting, friction materials, special articles, etc. Waste waters may result from the cleaning of the preparation and application equipment, dumps, and from the housekeeping operations. The other manufacturing operation that may result in waste waters is the recovery of solvents from drying oven exhaust air using activated carbon. The solvents are removed from the exhaust air by absorption on the carbon, recovered from the carbon by steam stripping, and then decanted or distilled from the condensate. The resulting waste water may contain residual solvent or other materials evaporated from the product during drying. Solvent recovery is not unique with the asbestos textile industry, but is used to a limited degree in the manufacture of friction materials and sheet gasketing. The presence or absence of this operation provides a basis for categorizing plants in the industry.

Characteristics and Treatability of Waste Waters

The term "characteristics" is used here to include both the intensive and extensive properties of the waste waters, i.e., the chemical and physical parameters plus the volumes of wastes and the rates of discharge. Most of the significant waste water pollutants from this industry fall broadly into two categories; dissolved organic materials (COD) from the textile coating and the solvent recovery and vapor absorption operations; and suspended solids from the wet particulate collectors. While the organic materials have some similarities, they vary in their amenability to various treatment technologies. The rates of discharge are so dissimilar that different control measures and effluent limitations are indicated. In one case (textile coating), a very small quantity of concentrated waste is discharged irregularly. In the second case (solvent recovery), a steady flow of moderate volume results. In the third (vapor absorption), a larger volume of dilute waste is discharged, but only intermittently. The different characteristics make different control and treatment technologies appropriate. The quality of the discharge from the dust collectors varies with the type of equipment and the degree of water recirculation, as well as the particulate load in the air stream.

While categorization based on the waste water characteristics is useful, this factor cannot be fully utilized. As noted in the discussion on raw materials above, there is only a small number of sources in this industry and each produces an effluent that is truly unique. There is little benefit in classifying plants if the result is only one plant in each category.

Air Pollution Control Equipment

In most of the plants in this industry, particulate emissions are controlled by baghouses or other dry devices. In a few plants, wet dust collectors are used and a waste water results.

Where small quantities of solvents are used, they may be wasted rather than recovered. Among the techniques used for controlling the emissions of vaporized materials is absorption in water, which may result in a waste water effluent.

The type of air pollution control equipment used in this industry provides a useful basis for categorization.

Plant Size

The plants in this industry that generate waste waters range from the small (50 to 70 employees) to the medium in size (1000 employees). As pointed out previously, the characteristics of the waste waters are independent of the level of production, and some of the small plants generate more waste than larger ones. Plant size has no significant effect on the quality or treatability of the waste waters.

Plant Age

The ages of the plants in this part of the asbestos manufacturing industry range from a few to 50 or more years. The manufacturing equipment is normally younger than the building housing the plant. Plant age, like plant size, could not be correlated with operational efficiency, quality of housekeeping, or waste water characteristics. Plant age is not an appropriate basis for categorization of the industry.

Geographic Location

As presented in Section III, almost all of the plants in this part of the asbestos manufacturing industry are located east of the Mississippi River. A few plants are located in California and Texas. The basic manufacturing processes used are similar throughout the industry, and geographic location does not influence the processes or the waste water characteristics. Location does not provide a basis for categorizing this industry.

SECTION V

WATER USE AND WASTE CHARACTERIZATION

Other than for steam generation and noncontact cooling, water is not widely used in the manufacturing processes in this part of the asbestos industry. In a few individual plants, water is used in process-related operations and waste waters are discharged from the plant property. The water usage and waste characteristics are described in detail in this section.

It should be noted that there are manufacturing processes that are termed "wet" within this industry, but are actually dry in that no waste water is generated. Examples include the "wet mixed" methods for manufacturing molded friction products. Solvents are used to make the mix more pliable during the rolling, extruding, or other molding operation. Another example is the addition of moisture to asbestos yarn during weaving to produce a tighter fabric. This is accomplished by mist sprays or by running the yarn through water. In the textile mills that "wet" weave, no excess water is used, and, in fact, there are no floor drains in the weaving areas.

For each of the subcategories in this industry, the waste water characteristics are described below. Because only a small number of plants generate process-related waste waters, the data base is not large. Each plant is unique and the information presented here is based on all data that are available about these waste waters.

TEXTILE COATING

Waste waters result from the coating of asbestos textiles at two plants in the country at the present time. Where textile products are coated (impregnated) in the manufacture of friction materials and sealing devices, water is not used and no waste water is generated.

Water Usage

The volume of waste generated in the coating of asbestos textiles is estimated to be no more than 750 liters (200 gallons) per day. The coating of asbestos textiles is not presently a full-time operation at either of the two plants. The waste results from dumps and cleanup at the end of a run, the amount of which is dependent on the number and length of the runs.

Waste Characteristics

Coated asbestos textiles are used in a variety of products; e.g., pipe lagging, paper machine felts, ironing board covers, etc. One of the purposes of coating is to encase the fibers, thereby reducing the potential health hazards in fabricating and using the final products. The coating has additional functions and its composition is normally specified by the fabricator. Consequently, the chemical constituents of the coating material, and subsequently those of the waste water, vary at each of the plants. The ingredients include resins, elastomers, pigments, solvents, and fillers. The wastes are high in COD and suspended and dissolved solids. In addition to the organic components, trace quantities of heavy metals, phosphates, and fluorides may be present.

At both of the plants that coat asbestos textiles, the waste waters are discharged to municipal sewerage systems, one with pretreatment and the other without. Other than knowing the quantities of raw materials used, neither plant has information on the characteristics of its waste waters.

SOLVENT RECOVERY

Waste waters are known to be generated in solvent recovery operations at two plants in this industry.

Water Usage

The quantity of waste water from solvent recovery operations varies, depending upon the type and the size of the equipment. A typical value is 38,000 liters (10,000 gallons) per day for this industry. The discharge is normally steady and, although it is a function of the activated carbon regeneration process, it can be related to the level of production in the plant.

Waste Characteristics

The waste waters from solvent recovery units may contain residual solvent and/or other organic materials that are either evaporated from the product or generated during the recovery operations. The suspended solids level is normally very low, and the waste water may have an elevated temperature. Typical waste water characteristics from one solvent recovery operation are as follows:

BOD (5-day)	1125 mg/l
COD	1930 mg/l
Suspended Solids	0 mg/l

The waste waters from this plant are discharged with the sanitary wastes to the municipal sewerage system. The waste waters from the other known plant that recovers solvent are combined with larger volumes of industrial waste waters (covered in the Phase I report on the asbestos industry) for treatment prior to discharge to a surface water. The BOD of the combined, treated effluent from the plant is less than 20 mg/l. There are plans at this plant to completely recycle all process-related waste waters.

VAPOR ABSORPTION

At one of the two asbestos textile coating plants, a vapor absorption unit is used to scrub solvent from the drying oven exhaust.

Water Usage

The fume scrubber at the single known installation in this industry is operated once or twice a month for a two-shift period each time. The water usage rate is about 3.8 liters per second (60 gallons per minute) for a total volume per period of approximately 220 cubic meters (58,000 gallons). The scrubber comprises four chambers, and water is recirculated within the unit.

Waste Characteristics

The vapor absorption unit is charged with 22.7 kilograms (50 pounds) of sodium hydroxide in solution for each period of operation. The resulting waste water, therefore, contains this caustic plus the absorbed solvent. The waste is pretreated in a two-stage lagoon prior to discharge to the municipal sewerage system. There are no records available that describe the characteristics of the raw waste water resulting from the vapor absorption unit. It should have a somewhat elevated pH value and a significant COD content.

WET DUST COLLECTION

At this time, there are known to be four friction materials manufacturing plants that discharge waste waters from wet dust collection equipment. Based on the results of this study, it is estimated that the total number of such plants in the country is no more than eight. At all of the known plants, the waste waters are clarified before discharge to surface waters. At one of the four, the wastes are combined with metal-finishing wastes in a physical-chemical treatment facility.

Water Usage

The water use rate in wet dust collectors varies from 0.06 to 1.3 liters per second per cubic meter per minute of air scrubbed (0.5 to 10 gpm per 1000 scfm). The plant air systems that are served by wet scrubbers that discharge waste waters from the plant property range from 280 to 7000 cubic meters per minute (10,000 to 250,000 scfm), resulting in waste water discharges of from 190 to 21,000 cubic meters (50,000 to 750,000 gallons) per day. The units that incorporate recirculation discharge a settled slurry. In addition, the contents of the settling tank are dumped, usually once per week. As noted above, the wastes are discharged to a settling lagoon in all known cases.

Waste Characteristics

The waste waters from the wet dust collectors are slurries of the dust emanating from the grinding and drilling operations used in finishing friction products. The principal parameter for characterizing the wastes is suspended solids. Because friction materials are specifically designed to shed water, it is unlikely that the dust is solubilized to any measurable degree. The COD test provides a convenient means of detecting and monitoring this phenomenon if it is suspected.

The quantity of friction material that is lost in the finishing operations may be as much as 30 percent. It is significant that, even with the relatively high price of asbestos fiber, this material is not recovered for reuse. Once the resin has set up, it is not regarded as economical to break it down to salvage the fiber.

DISPERSION PROCESS

As noted in Section IV, there are two known experimental pilot-plant operations in the country where asbestos yarn is being produced in very limited quantities by the dispersion process. While these operations are too limited for inclusion as subcategories in this industry, it is deemed appropriate to include what information is available about the waste waters for use when and if this method becomes operational and is more widely used.

Water Usage

The water use rate is in the order of 20 to 60 cubic meters (5000 to 15,000 gallons) per day in these pilot-plant operations. Because these facilities are very small, water usage based on production cannot be realistically extrapolated to plant-scale operations. The water passes through save-alls in the process and there is at least a potential for recycle of water. Because of the waste characteristics, it is not feasible at this time to completely reuse all water in this process.

Waste Characteristics

The waste waters from the two plants that are developing the dispersion process differ significantly, in part because the processes are not exactly the same. It is possible that the wastes will change significantly as the processes are refined and developed. Some of the parameters that should be measured are total and suspended solids; COD and BOD; hexane extractables; MBAS; zinc and other metals; and the plant nutrients, nitrogen and phosphorus.

PLANT DESCRIPTIONS

Forty-five manufacturing plants representing 30 different companies or corporations were contacted directly in this study. Information was collected from six additional plants through a questionnaire. This coverage is believed to include better than 80 percent of all the plants that are properly within the two SIC classes, and it represents an accurate picture of this segment of the asbestos manufacturing industry. A total of ten plants were found that discharge process-related waste waters. These plants are described individually in Table 2.

In reviewing Table 2, it should be noted that the discharges from the two plants using the dispersion process for making asbestos yarn are included, even though these operations are experimental and not yet classified as subcategories of this industry. Of the remaining eleven waste streams, seven result from air pollution control equipment and only four from manufacturing and associated operations.

TABLE 2

GENERAL DESCRIPTION OF KNOWN WASTE WATER SOURCES ASBESTOS MANUFACTURING PLANTS - PHASE II

Plant	Product	Waste Water Source	Treatment Provided	Effluent Discharged To
A	Textiles	Coating	None	Municipal Sewer
B	Textiles	Coating	Two-Stage Lagoon	Municipal Sewer
"	"	Fume Scrubber	" "	" "
C	Textiles	Dispersion Process	Filtration	Municipal Sewer
D	Textiles	Dispersion Process	None/Lagoon	Municipal Sewer/ Surface Water
"	Sheet Gasketing	Solvent Recovery	Lagoon	Surface Water
E	Friction Materials	Dust Scrubber	Lagoon	No Discharge
F	Friction Materials	Dust Scrubber	Sedimentation	Surface Water
G	Friction Materials	Dust Scrubber	Two-Stage Lagoon	Surface Water
H	Friction Materials	Dust Scrubber	Lagoon	Surface Water

TABLE 2 (cont)

GENERAL DESCRIPTION OF KNOWN WASTE WATER SOURCES
ASBESTOS MANUFACTURING PLANTS - PHASE II

Plant	Product	Waste Water Source	Treatment Provided	Effluent Discharged To
I	Friction Materials	Solvent Recovery	None	Municipal Sewer
"	" "	Dust Scrubber	Lagoon	No Discharge
J	Friction Materials	Dust Scrubber	Chemical Precipitation with Other Wastes	Surface Water

SECTION VI

SELECTION OF POLLUTANT PARAMETERS

The chemical, physical, and biological parameters that define the pollutant constituents in process-related waste waters from this part of the asbestos manufacturing industry are the following:

COD (or TOC)
Suspended Solids
pH
Temperature
BOD
Dissolved Solids
Heavy Metals
Phenols
Nitrogen
Phosphorus

The first two listed parameters are the most significant and useful in characterizing the wastes from this industry. The others are included because they may also be significant in one or more subcategories or because they supplement and support the first two listed parameters. The rationale for selection of the listed parameters is given below.

Pollutants in non-process waste waters, such as noncontact cooling water, boiler blowdown, steam condensate, and wastes from water sanitary facilities, are not included in this document.

MAJOR POLLUTANTS

The reasons for including the above listed parameters are briefly presented below. The reader is referred to other sources (Section XIII) for detailed descriptions of the parameters and procedures for measuring them.

Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) provides a measure of the equivalent oxygen required to chemically oxidize the organic and inorganic material present in a waste water. In this part of the asbestos industry, the COD serves as the primary parameter for measuring the organic materials in the raw and treated wastes, including solvents, resins, elastomers, and fillers. COD values in excess of 1000 mg/l occur in the wastes from the textile coating and solvent recovery subcategories. In order to be most meaningful when used to monitor solubilization in wet dust collection subcategory, the sample should be filtered prior to COD analysis.

If desired, the Total Organic Carbon (TOC) parameter may be substituted for COD, with the appropriate adjustments in values. This

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instrumental technique yields results in terms of carbon concentrations, rather than oxygen.

Suspended Solids

The suspended solids parameter is especially useful with the waste water from the wet dust collectors and textile coating subcategories. The suspended solids level in the raw wastes may range up to the very high values, exceeding 10,000 mg/l, depending upon the operational mode of the equipment, i.e., the level of dilution used. The suspended solids in the waste waters from the solvent recovery and vapor absorption subcategories should be negligible if the equipment is properly operated.

Suspended solids include both organic and inorganic materials. The inorganic components include sand, silt, and clay. The organic fraction includes such materials as grease, oil, tar, animal and vegetable fats, various fibers, sawdust, hair, and various materials from sewers. These solids may settle out rapidly and bottom deposits are often a mixture of both organic and inorganic solids. They adversely affect fisheries by covering the bottom of the stream or lake with a blanket of material that destroys the fish-food bottom fauna or the spawning ground of fish. Deposits containing organic materials may deplete bottom oxygen supplies and produce hydrogen sulfide, carbon dioxide, methane, and other noxious gases.

In raw water sources for domestic use, state and regional agencies generally specify that suspended solids in streams shall not be present in sufficient concentration to be objectionable or to interfere with normal treatment processes. Suspended solids in water may interfere with many industrial processes, and cause foaming in boilers, or encrustations on equipment exposed to water, especially as the temperature rises. Suspended solids are undesirable in water for textile industries; paper and pulp; beverages; dairy products; laundries; dyeing; photography; cooling systems; and power plants. Suspended particles also serve as a transport mechanism for pesticides and other substances which are readily sorbed into or onto clay particles.

Solids may be suspended in water for a time, and then settle to the bed of the stream or lake. These settleable solids discharged with man's wastes may be inert, slowly biodegradable materials, or rapidly decomposable substances. While in suspension, they increase the turbidity of the water, reduce light penetration and impair the photosynthetic activity of aquatic plants.

Solids in suspension are aesthetically displeasing. When they settle to form sludge deposits on the stream or lake bed, they are often much more damaging to the life in water, and they retain the capacity to displease the senses. Solids, when transformed to sludge deposits, may do a variety of damaging things, including blanketing the stream or lake bed and thereby destroying the living spaces for those benthic organisms that would otherwise occupy the habitat. When of an organic and therefore decomposable nature, solids use a portion or all of the dissolved oxygen available in the area. Organic materials also serve as a seemingly inexhaustible food source for sludgeworms and associated organisms.

Turbidity is principally a measure of the light absorbing properties of suspended solids. It is frequently used as a substitute method of quickly estimating the total suspended solids when the concentration is relatively low.

OTHER POLLUTANTS

pH, Acidity, and Alkalinity

Normally, waste waters in the four subcategories fall in the neutral pH range, i.e., 6 to 9. In the vapor absorption subcategory, however, alkali is used in the scrub water and the pH may be above 9. Because this parameter is readily measurable and because it provides an indication of changes or upsets, it should be included in the list of regularly monitored parameters.

Acidity and alkalinity are reciprocal terms. Acidity is produced by substances that yield hydrogen ions upon hydrolysis and alkalinity is produced by substances that yield hydroxyl ions. The terms "total acidity" and "total alkalinity" are often used to express the buffering capacity of a solution. Acidity in natural waters is caused by carbon dioxide, mineral acids, weakly dissociated acids, and the salts of strong acids and weak bases. Alkalinity is caused by strong bases and the salts of strong alkalies and weak acids.

The term pH is a logarithmic expression of the concentration of hydrogen ions. At a pH of 7, the hydrogen and hydroxyl ion concentrations are essentially equal and the water is neutral. Lower pH values indicate acidity while higher values indicate alkalinity. The relationship between pH and acidity or alkalinity is not necessarily linear or direct.

Waters with a pH below 6.0 are corrosive to water works structures, distribution lines, and household plumbing fixtures and can thus add such constituents to drinking water as iron, copper, zinc, cadmium, and lead. The hydrogen ion concentration can affect the "taste" of the water. At a low pH water tastes "sour". The bactericidal effect of chlorine is weakened as the pH increases, and it is advantageous to keep the pH close to 7. This is very significant for providing safe drinking water.

Extremes of pH or rapid pH changes can exert stress conditions or kill aquatic life outright. Dead fish, associated algal blooms, and foul stenches are esthetic liabilities of any waterway. Even moderate changes from "acceptable" criteria limits of pH are deleterious to some species. The relative toxicity to aquatic life of many materials is increased by changes in the water pH. Metalocyanide complexes can increase a thousand-fold in toxicity with a drop of 1.5 pH units. The availability of many nutrient substances varies with the alkalinity and acidity. Ammonia is more lethal with a higher pH.

The lacrimal fluid of the human eye has a pH of approximately 7.0 and a deviation of 0.1 pH unit from the norm may result in eye irritation for the swimmer. Appreciable irritation will cause severe pain.

Temperature

The waste waters associated with the solvent recovery category may be hot, with temperatures as high as 80°C if distillation is used to separate the solvent from the condensed steam. Because elevated water temperatures influence the efficiency of treatment technologies and are harmful to aquatic life, the temperature of the raw wastes should be monitored.

Temperature is one of the most important and influential water quality characteristics. Temperature determines those species that may be present; it activates the hatching of young, regulates their activity, and stimulates or suppresses their growth and development; it attracts, and may kill when the water becomes too hot or becomes chilled too suddenly. Colder water generally suppresses development. Warmer water generally accelerates activity and may be a primary cause of aquatic plant nuisances when other environmental factors are suitable.

Temperature is a prime regulator of natural processes within the water environment. It governs physiological functions in organisms and, acting directly or indirectly in combination with other water quality constituents, it affects aquatic life with each change. These effects include chemical reaction rates, enzymatic functions, molecular movements, and molecular exchanges between membranes within and between the physiological systems and the organs of an animal.

Chemical reaction rates vary with temperature and generally increase as the temperature is increased. The solubility of gases in water varies with temperature. Dissolved oxygen is decreased by the decay or decomposition of dissolved organic substances and the decay rate increases as the temperature of the water increases reaching a maximum at about 30°C (86°F). The temperature of stream water, even during summer, is below the optimum for pollution-associated bacteria. Increasing the water temperature increases the bacterial multiplication rate when the environment is favorable and the food supply is abundant.

Reproduction cycles may be changed significantly by increased temperature because this function takes place under restricted temperature ranges. Spawning may not occur at all because temperatures are too high. Thus, a fish population may exist in a heated area only by continued immigration. Disregarding the decreased reproductive potential, water temperatures need not reach lethal levels to decimate a species. Temperatures that favor competitors, predators, parasites, and disease can destroy a species at levels far below those that are lethal.

Fish food organisms are altered severely when temperatures approach or exceed 90°F. Predominant algal species change, primary production is decreased, and bottom associated organisms may be depleted or altered drastically in numbers and distribution. Increased water temperatures may cause aquatic plant nuisances when other environmental factors are favorable.

Synergistic actions of pollutants are more severe at higher water temperatures. Given amounts of domestic sewage, refinery wastes, oils, tars, insecticides, detergents, and fertilizers more rapidly deplete oxygen in water at higher temperatures, and the respective toxicities are likewise increased.

When water temperatures increase, the predominant algal species may change from diatoms to green algae, and finally at high temperatures to blue-green algae, because of species temperature preferentials. Blue-green algae can cause serious odor problems. The number and distribution of benthic organisms decreases as water temperatures increase above 90°F, which is close to the tolerance limit for the population. This could seriously affect certain fish that depend on benthic organisms as a food source.

The cost of fish being attracted to heated water in winter months may be considerable, due to fish mortalities that may result when the fish return to the cooler water.

Rising temperatures stimulate the decomposition of sludge, formation of sludge gas, multiplication of saprophytic bacteria and fungi (particularly in the presence of organic wastes), and the consumption of oxygen by putrefactive processes, thus affecting the esthetic value of a watercourse.

In general, marine water temperatures do not change as rapidly or range as widely as those of freshwaters. Marine and estuarine fishes, therefore, are less tolerant of temperature variation. Although this limited tolerance is greater in estuarine than in open water marine species, temperature changes are more important to those fishes in estuaries and bays than to those in open marine areas, because of the nursery and replenishment functions of the estuary that can be adversely affected by extreme temperature changes.

Biochemical Oxygen Demand (BOD)

The Biochemical Oxygen Demand (BOD) technique provides a means of estimating the usefulness of biological treatment processes for controlling the discharge of organic pollutants. It also provides an indication of the effect of the waste on the oxygen budget in a receiving water. For this part of the asbestos industry, the BOD parameter extends the COD results and is useful when biotreatment is under consideration. Some of the organic materials present in the waste waters are not readily biodegradable, however, and will not respond in the test.

Biochemical oxygen demand (BOD) is a measure of the oxygen consuming capabilities of organic matter. The BOD does not in itself cause direct harm to a water system, but it does exert an indirect effect by depressing the oxygen content of the water. Sewage and other organic effluents during their processes of decomposition exert a BOD, which can have a catastrophic effect on the ecosystem by depleting the oxygen supply. Conditions are reached frequently where all of the oxygen is used and the continuing decay process causes the production of noxious gases such as hydrogen sulfide and methane. Water with a high BOD indicates the presence of decomposing organic matter and subsequent high bacterial counts that degrade its quality and potential uses.

Dissolved oxygen (DO) is a water quality constituent that, in appropriate concentrations, is essential not only to keep organisms living but also to sustain species reproduction, vigor, and the development of populations. Organisms undergo stress at reduced DO concentrations that make them less competitive and able to sustain their species within the aquatic environment. For example, reduced DO concentrations have been shown to interfere with fish population through delayed hatching of eggs, reduced size and vigor of embryos, production of deformities in young, interference with food digestion, acceleration of blood clotting, decreased tolerance to certain toxicants, reduced food efficiency and growth rate, and reduced maximum sustained swimming speed. Fish food organisms are likewise affected adversely in conditions with suppressed DO. Since all aerobic aquatic organisms need a certain amount of oxygen, the consequences of total lack of dissolved oxygen due to a high BOD can kill all inhabitants of the affected area.

If a high BOD is present, the quality of the water is usually visually degraded by the presence of decomposing materials and algae blooms due to the uptake of degraded materials that form the foodstuffs of the algal populations.

Dissolved Solids

The dissolved solids content, when coupled with the suspended solids value, provides a measure of the total quantity of foreign material present in a waste water. With the wastes in this industry, the dissolved solids parameter is useful in corroborating the accuracy of the COD results. Since the analytical procedure involves evaporation, some organic materials, e.g., certain solvents, may not be detected.

In natural waters the dissolved solids consist mainly of carbonates, chlorides, sulfates, phosphates, and possibly nitrates of calcium, magnesium, sodium, and potassium, with traces of iron, manganese and other substances.

Many communities in the United States and in other countries use water supplies containing 2000 to 4000 mg/l of dissolved salts, when no better water is available. Such waters are not palatable, may not quench thirst, and may have a laxative action on new users. Waters containing more than 4000 mg/l of total salts are generally considered unfit for human use, although in hot climates such higher salt concentrations can be tolerated whereas they could not be in temperate climates. Waters containing 5000 mg/l or more are reported to be bitter and act as bladder and intestinal irritants. It is generally agreed that the salt concentration of good, palatable water should not exceed 500 mg/l.

Limiting concentrations of dissolved solids for fresh-water fish may range from 5,000 to 10,000 mg/l, according to species and prior acclimatization. Some fish are adapted to living in more saline waters, and a few species of fresh-water forms have been found in natural waters with a salt concentration of 15,000 to 20,000 mg/l. Fish can slowly become acclimatized to higher salinities, but fish in waters of low salinity cannot survive sudden exposure to high salinities, such as those resulting from discharges of oil-well brines. Dissolved solids may influence the toxicity of heavy metals and organic compounds to fish and other aquatic life, primarily because of the antagonistic effect of hardness on metals.

Waters with total dissolved solids over 500 mg/l have decreasing utility as irrigation water. At 5,000 mg/l water has little or no value for irrigation.

Dissolved solids in industrial waters can cause foaming in boilers and cause interference with cleanliness, color, or taste of many finished products. High contents of dissolved solids also tend to accelerate corrosion.

Specific conductance is a measure of the capacity of water to convey an electric current. This property is related to the total concentration of ionized substances in water and water temperature. This property is frequently used as a substitute method of quickly estimating the dissolved solids concentration.

Heavy Metals

Some of the additives used in the textile coating subcategory contain heavy metals, generally in the form of inert particulates. The raw wastes should be monitored for any metals that are suspected to be present in soluble forms in the raw materials to ascertain possible need for controls.

Phenols

The waste waters from one solvent recovery operation are known to contain about 12 mg/l of phenol. This material is derived from the material used to impregnate woven friction materials and is evaporated from the product in the drying oven. Phenols, however, are only a very minor portion of the total organic materials and should not require specific controls and limitations beyond those applicable to COD.

Phenols and phenolic wastes are derived from petroleum, coke, and chemical industries; wood distillation; and domestic and animal wastes. Many phenolic compounds are more toxic than pure phenol; their toxicity varies with the combinations and general nature of total wastes. The effect of combinations of different phenolic compounds is cumulative.

Phenols and phenolic compounds are both acutely and chronically toxic to fish and other aquatic animals. Also, chlorophenols produce an unpleasant taste in fish flesh that destroys their recreational and commercial value.

It is necessary to limit phenolic compounds in raw water used for drinking water supplies, as conventional treatment methods used by water supply facilities do not remove phenols. The ingestion of concentrated solutions of phenols will result in severe pain, renal irritation, shock and possibly death.

Phenols also reduce the utility of water for certain industrial uses, notably food and beverage processing, where it creates unpleasant tastes and odors in the product.

Nitrogen

The nitrogen levels in the waste waters from the subcategories covered here are not known to be significantly high. Nitrogen-containing compounds are used as additives in the textile coating formulations. Addition of nitrogen may be required for effective biological treatment.

Phosphorus

Like nitrogen, there are no reliable data as to phosphorus levels in the wastes in this part of the asbestos industry. Phosphorus-containing materials are used in small amounts in the textile coating formulations, but phosphorus content of waste waters should be very low. Addition of phosphorus as a nutrient may be necessary for biological treatment.

During the past 30 years, a formidable case has developed for the belief that increasing standing crops of aquatic plant growths, which often interfere with water uses and are nuisances to man, frequently are caused by increasing supplies of phosphorus. Such phenomena are associated with a condition of accelerated eutrophication or aging of waters. It is generally recognized that phosphorus is not the sole cause of eutrophication, but there is evidence to substantiate that it is frequently the key element in all of the elements required by fresh water plants and is generally present in the least amount relative to need. Therefore, an increase in phosphorus allows use of other, already present, nutrients for plant growths. Phosphorus is usually described, for this reasons, as a "limiting factor."

When a plant population is stimulated in production and attains a nuisance status, a large number of associated liabilities are immediately apparent. Dense populations of pond weeds make swimming dangerous. Boating and water skiing and,sometimes, fishing may be eliminated because of the mass of vegetation that serves as an physical impediment to such activities. Plant populations have been associated with stunted fish populations and with poor fishing. Plant nuisances emit vile stenches, impart tastes and odors to water supplies, reduce the efficiency of industrial and municipal water treatment, impair esthetic beauty, reduce or restrict resort trade, lower waterfront property values, cause skin rashes to man during water contact, and serve as a desired substrate and breeding ground for flies.

Phosphorus in the elemental form is particularly toxic, and subject to bioaccumulation in much the same way as mercury. Colloidal elemental phosphorus will poison marine fish (causing skin tissue breakdown and discoloration). Also, phosphorus is capable of being concentrated and will accumulate in organs and soft tissues. Experiments have shown that marine fish will concentrate phosphorus from water containing as little as 1 mg/l.

SECTION VII

CONTROL AND TREATMENT TECHNOLOGY

INTRODUCTION

When classified in terms of the major waste water pollutants, those segments of the asbestos manufacturing industry covered in this document fall into two groups: (1) textile coating, solvent recovery, and vapor absorption; and (2) wet dust collection. The waste waters from the first group contain significant levels of organic materials in solution. The raw wastes from textile coating may also contain suspended materials that will settle in quiescent conditions. The wastes from wet dust collectors are entirely suspended solids with minimal dissolved organic content. Some of the in-plant control measures apply to both groups, but the end-of-pipe treatment technologies are basically different.

Treatment

Within this industry, the only end-of-pipe treatment technology in use is sedimentation, normally in lagoons. While this operation may be adequate for waste waters from wet dust collectors, it is inappropriate as the sole method of treatment for the first group of subcategories. It should be pointed out that some friction materials manufacturing plants provide treatment beyond sedimentation. These are primarily for wastes from non-asbestos manufacturing, e.g., metal finishing operations, and wastes from the wet dust collectors are treated in the same facility.

The control technologies recommended here are addressed at the principal pollutant parameters, namely COD, suspended solids, and pH. There are insufficient data available to ascertain the need for additional control measures for such dissolved pollutants as heavy metals, phenols, and plant nutrients. In most of the known cases, the costs of end-of-pipe treatment technologies more advanced than those recommended here are so high that alternative solutions will be used, e.g., substitution of baghouses for wet dust scrubbers in friction materials plants. At some of the plants, such a substitution program, on a phased schedule, has already been initiated.

Implementation

Based on the available information, the in-plant control measures and end-of-pipe treatment technology outlined below can be implemented as necessary within the appropriate subcategories of the industry. Factors relating to plant and equipment age, manufacturing process and capacity, and land availability do not generally play significant roles in determining whether a given plant can make the changes. Because so few plants are actually affected today, the recommended technology has been defined with all of the known plants in mind. Implementation of a particular control or treatment

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measure will involve approximately the same degree of engineering and process design skill and will have the same effects on plant operations, product quality, and process flexibility at all locations. Each plant is unique, however, and the possibility of peculiar requirements should not be ignored.

IN-PLANT CONTROL MEASURES

In some friction materials plants, water is recirculated in the wet dust collectors. This is the only in-plant control measure that is generally used in this industry. Other in-plant measures, as described below, have been implemented at individual plants to eliminate the generation or discharge of process-related waste waters.

Raw Material Storage

Raw materials are normally stored indoors and in containers. There is no widespread water pollution problem related to improper or inadequate raw material storage practices.

Waste Water Segregation

In all cases, sanitary sewage should be discharged separately from process-related waste waters. Public health considerations as well as economic factors dictate that sanitary wastes not be combined with process-related wastes for on-site treatment.

In all four subcategories, the waste waters originate at one point in the process or the auxiliary operation. The wastes, therefore, can be isolated for separate control. In many plants, the wastes are diluted with cleaner waters, such as spent cooling water and steam condensate. By mixing these streams, the entire discharge becomes, by definition, a process-related waste subject to control. These clean water discharges should be segregated and managed separately.

Housekeeping Practices

The only subcategory where housekeeping practices influence the quality of the waste water is textile coating. Since the waste results primarily from clean-up of equipment and dumps, changes here can result in significant improvements in the quality of the waste waters.

Water Usage

Attention should be directed toward water conservation in all subcategories. In the clean-up operations in asbestos textile coating, there is a tendency to use more water than is required. The water used in the vapor absorption and dust collection equipment should be reduced to the minimal level dictated by air quality requirements. Spent cooling water, where available, can be used for these operations.

As described below for three of the four individual subcategories, water usage can be eliminated through substitution of alternative procedures or equipment.

TREATMENT TECHNOLOGY

Included with end-of-pipe treatment technologies are those in-plant modifications that are more than control measures, e.g., substitution of dry air pollution control equipment for wet scrubbers. This is regarded as a logical arrangement because the changes are separate from the manufacturing processes, major equipment installation is required, and both relate to protection of environmental quality through treatment.

Technical Considerations

The recommended control and treatment technologies are believed to be applicable to the appropriate subcategories, as outlined below, and are based on the limited data available. It is conceivable that unknown factors would render a particular technology inoperative at a given plant. The steps described here cannot, therefore, be applied without careful analysis of each plant's wastes and particular requirements.

Application

The control and treatment technologies recommended here can be applied regardless of plant size and capacity, the manufacturing process, or plant and equipment age. The design can be altered to fit the plant's needs, and the wastes from both large and small plants can be managed efficiently using these technologies.

Land Requirements

All of the recommended control and treatment technologies require relatively little land area; less than 0.1 hectare (0.25 acre) in all cases. If more land is available at a given plant, larger facilities may be employed to reduce operating costs.

The additional land required for disposal of containerized liquid wastes resulting from the technologies described here are not large. The waste water volumes are relatively small when compared to many industries, and the volumes of waste generated for land disposal are also relatively small.

Compatibility of Control Measures

In some categories, the control technologies may be based on treatment to reduce the pollutants to acceptable levels prior to discharge or may involve substitution of equipment so that no waste water is generated. The two levels are incompatible in that the money spent in implementing the first level controls is lost when the second level controls are installed. Since half of the plants known to be generating process waste waters now discharge to municipal sewerage systems, the decision takes on added dimensions.

INDUSTRY SUBCATEGORIES

The control measures and treatment technologies that are applicable to the separate subcategories of this part of the asbestos industry are described below.

Asbestos Textile Coating

The wastes from textile coating result from clean-up and dumping of unused coating material at the end of a run. The waste waters are small in volume and relatively concentrated. Because of the high cost of treating this waste to make it suitable for discharge to a surface water, the recommended control measure is containment of the waste in undiluted form and containerization for salvage or land disposal. The required quantities of finishing material for each run should be estimated and prepared so that a minimal amount remains to be disposed of. Dry cleaning techniques should be substituted for wet methods. Measures should be taken to eliminate or contain spills and dripped material. The waste should be placed in appropriate containers, e.g., steel drums, for salvage by a commercial waste handling firm, if available, or for disposal in a controlled sanitary landfill. If no commercial handling firm is available and State or local regulations prohibit disposal of solvents in sanitary landfills, it may be necessary to employ small batch incinerators for disposal of the reduced volumes of waste. These alternative methods of disposal must be in compliance with the appropriate regulations affecting such disposal.

Solvent Recovery

At least one plant in this industry recovers solvent without generating waste water pollutants. It appears that this technique is not applicable at other plants using different solvents. The solvent recovery waste waters may contain significant organic loads and may have an elevated temperature.

If the organic material is not refractory, bio-treatment by the activated sludge process after cooling, as necessary, would be suitable for meeting the limitations. For the scale of operations encountered in this industry, i.e., approximately 40 cubic meters (10,000 gallons) per day, the extended aeration variation would be appropriate. Excess sludge could be removed by a commercial hauler for disposal at a municipal treatment plant.

If the waste is refractory to bio-treatment, adsorption on activated carbon is recommended. If properly designed and operated, this process should reduce the concentrations of organic materials to acceptable levels. Because of the relatively small volume to be handled, carbon regeneration by the supplier would probably be more economical than on-site thermal regeneration.

In preparing to apply either of the treatment technologies described above, their suitabilities for a particular waste stream must be evaluated. There are standardized testing procedures to measure both the biodegradability and sorptive characteristics of waste waters. In the event that neither of these technologies is feasible, more sophisticated processes, such as reverse osmosis, are available to achieve the desired results.

Vapor Absorption

The waste water from vapor absorption operations resembles that from solvent recovery in that it contains organic material and has a negligible suspended solids content. In this industry, however, the vapor absorption operations are operated intermittently, and bio-treatment processes are not feasible. All biological facilities require a reasonably steady inflow of waste to function effectively. Carbon adsorption should be effective with these wastes, however. Adjustment of the pH to a lower level would probably be beneficial to increase the efficiency of the carbon.

Since recovery of the solvent is not a goal in vapor absorption, a fume incinerator could be substituted to remove the vapor from the exhaust air. Both direct-fired and catalytic types are available and either should be suitable for this application. Detailed information about the design, operation, costs, and applicability of various types of incinerators is beyond the scope of this report and is readily available in the technical literature on air pollution control. The use of an incinerator would eliminate the discharge of waste water in this subcategory.

Wet Dust Collection

The waste waters from wet dust collectors are amenable to treatment by sedimentation, with coagulation as necessary. There are no data available on the efficiency of plain sedimentation, but there is no reason to believe that it would not be effective.

While the dust particles have a significant organic content, they are not treatable by such processes as bio-treatment or activated carbon adsorption. If treatment beyond sedimentation is indicated, filtration would be the logical next step and complete removal could be accomplished. A more appropriate means of solving this problem is to substitute dry dust collectors, e.g., baghouses, for the wet scrubbers. This step, which is already being taken at some of the plants in this industry, eliminates the discharge of waste water in this subcategory. Detailed information about the engineering aspects of the available equipment for dry collection of particulates is beyond the scope of this report and is available in the literature dealing with air pollution control.

SECTION VIII

COST, ENERGY, AND NON-WATER QUALITY ASPECTS

An analysis of the estimated costs and pollution control benefits of alternative control and treatment technologies applicable to this part of the asbestos manufacturing industry is given in this section.

The cost estimates were developed using data from various sources, including the contractor's files and the general information on costs referenced in Section XIII. There was very little useful treatment cost data available from the industry. The existing treatment facilities are lagoons of various types and most of them receive large volumes of waste waters from sources not included in this report, e.g., spent cooling water or wastes from other manufacturing processes.

REPRESENTATIVE PLANTS

The representative plants used to develop treatment cost information are composites rather than actual plants. Because there are so few plants that generate waste waters, the composites represent all the known plants in the industry. The treatment technologies were developed for application to effluents discharged to surface waters, although half of the plants discharge to municipal sewerage systems. The costs are based on typical, standard control and treatment technologies that are either used elsewhere in this industry or are used with similar wastes from sources outside this industry. The waste flows were selected as typical for the plants, and where a significant range of flows exists, estimates for various sizes were developed.

The end-of-pipe control technologies were designed, for cost purposes, to require minimal space and land area. It is believed that, at most plants, no additional land would be required. At locations with more land available, larger, more economical facilities of equal efficiency may be used, e.g., a lagoon may be substituted for a mechanical clarifier.

In summary, the cost information is intended to apply to most plants in this industry. Differences in age or size of production facilities, level of implementation of in-plant controls, and local non-water quality environmental aspects all reduce to one basic variable, the volume of waste water discharged. The sizes of the representative composite manufacturing plants used for the four subcategories are presented in Table 3. For those subcategories where dry air pollution control equipment may be substituted, exhaust air flow rates that correspond approximately to the waste water flows are given.

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TABLE 3

REPRESENTATIVE MANUFACTURING PLANTS USED IN DEVELOPING COST ESTIMATES

Subcategory	Waste Water Flow		Exhaust Air Flow	
	cu m/day	mgd	cu m/min	scfm
Textile Coating	0.8	0.0002	NA*	NA
Solvent Recovery	38	0.01	NA	NA
Vapor Absorption	230**	0.06**	570	20,000
Wet Dust Collection:				
Small	190	0.05	280	10,000
Medium	380	0.10	850	30,000
Large	570	0.15	1700	60,000

* NA = Not Applicable.

** Total discharge per operating period.

COST INFORMATION

The investment and annual costs associated with the alternative control technologies for the four subcategories, as well as the effluent quality associated with each alternative, are summarized in Tables 4 through 9. All costs are reported in August, 1971 dollars.

Investment Costs

Investment costs are defined as the capital expenditures required to bring the treatment or control technology into operation. Included, as appropriate, are the costs of excavation, concrete, mechanical and electrical equipment installed, and piping. An amount equal to from 15 to 25 percent of the total of the above was added to cover engineering design services, construction supervision, and related costs. The lower percentages were used for the larger facilities. Because most of the control technologies involved external, end-of-plant systems, no cost was included for lost time due to installation. It is believed that the interruption required for installation of control technologies can be coordinated with normal plant shutdown and vacation periods in most cases. As noted above, the control facilities were estimated on the basis of minimal space requirements. Therefore, no additional land costs were included.

Capital Costs

The capital costs are calculated, in all cases, as 8 percent of the total investment costs. Consultations with representatives of industry and the financial community led to the conclusion that, with the limited data available, this estimate was reasonable for this industry.

Depreciation

Straight-line depreciation was used in all cases. The periods used were believed to be typical for the particular technology and are indicated in the footnotes on Tables 4 through 9.

Operation and Maintenance Costs

Operation and maintenance costs include labor, materials, solid waste disposal, effluent monitoring, added administrative expenses, taxes, and insurance. Manpower requirements were based upon a total salary cost of $10 per man-hour in all cases. The costs of chemicals used in treatment were added to the costs of materials used for maintenance and operation. The costs of solid waste handling and disposal were based primarily upon information supplied by the representative firms.

Energy and Power Costs

Energy costs were estimated on the basis of $0.025 per kilowatt-hour.

CONTROL TECHNOLOGIES WITH COSTS

The estimated costs and the associated reduction benefits for the alternative control technologies for each of the subcategories are presented below.

Textile Coating (Table 4)

Alternative A - No Waste Treatment or Control

Effluent waste load is a very small volume of concentrated organic material (COD) and suspended solids with potentially significant levels of heavy metals and plant nutrients. The waste is discharged on about half of the plant operating days.

Costs. None.

Reduction Benefits. None

Alternative B - Zero Discharge

Discharge of waste water is eliminated through in-plant control measures, including the use of dry cleaning methods and containment of dumped and spilled coating material. Waste is containerized for salvage by a commercial waste salvage firm or for disposal in a controlled sanitary landfill. Some in-plant control measures are now in use, e.g., minimizing dumps, but no plant completely retains all waste.

Costs. Investment cost is approximately $2,000.

Reduction Benefits. Reduction of all pollutant constituents of 100 percent.

Alternative C - Zero Discharge, Incineration

This alternative involves temporary storage of the waste residues followed by incineration in a liquid thermal oxidation unit. The inert ash goes to sanitary landfill.

Cost. Investment cost is approximately $28,000.

Reduction Benefits. Reduction of all pollutant constituents of 100 percent.

Solvent Recovery (Table 5)

Alternative A - No Waste Treatment or Control

Daily effluent waste load is estimated to be 75 kg (165 lb) of COD and 45 kg (100 lb) of BOD for the typical plant at this minimal control level. The suspended solids waste load is negligible. All known plants in the industry provide only this level of control.

TABLE 4

TYPICAL PLANT
WATER EFFLUENT TREATMENT COSTS
ASBESTOS MANUFACTURING
ASBESTOS TEXTILE COATING

Treatment or Control Technologies:	(Costs in $1000) A	B	C
Investment	-	2.0	28
Annual Costs:			
Capital Costs	-	0.2	2.3
Depreciation	-	0.2*	2.4**
Operating & Maintenance Costs (excluding energy & power costs)	-	8.0	2.2
Energy and Power Costs	-	Zero	1.3
Total Annual Cost	-	8.4	8.2

Effluent Quality:

Effluent Constituents	Raw Waste Load	Resulting Effluent Levels		
COD - mg/l	Variable	Variable	Zero	Zero
Suspended Solids - mg/l	Variable	Variable	Zero	Zero
pH	Variable	Variable	-	-

*Expected Lifetime - 10 years.
**Expected Lifetime - 12 years.

TABLE 5

TYPICAL PLANT
WATER EFFLUENT TREATMENT COSTS
ASBESTOS MANUFACTURING
SOLVENT RECOVERY

Treatment or Control Technologies:	A	B	C
	(Costs in $1000)		
Investment	-	73	146
Annual Costs:			
Capital Costs	-	5.9	11.7
Depreciation	-	2.9*	10.5**
Operating and Maintenance Costs (excluding energy and power costs)	-	12.5	20.6
Energy and Power Costs	-	11.0	1.0***
Total Annual Cost	-	32.3	43.8

Effluent Quality:

Effluent Constituents	Raw Waste Load	Resulting Effluent Levels		
BOD (5-day) - mg/l	1200	1200	30	5
COD - mg/l	2000	2000	50	5
Suspended Solids - mg/l	30	30	30	5
pH	6-9	6-9	6-9	6-9

* Expected lifetime - 25 years
** Expected lifetime - 14 years
*** Not including carbon regeneration

Costs. None.

Reduction Benefits. None.

Alternative B - Biological Treatment

This alternative involves using the extended aeration variation of the activated sludge process with removal of excess sludge to a municipal sewage treatment plant. The daily effluent waste load is estimated to be about 2 kg (5 lb) of COD and 1.1 kg (2.5 lb) of BOD with this alternative.

Costs. Investment costs are approximately $73,000.

Reduction Benefits. Estimated reduction of effluent COD and BOD of 97 percent.

Alternative C - Carbon Adsorption

This alternative involves treating the effluent from the bio-treatment process in 2-stage granular activated carbon columns. The carbon is regenerated off-site by the supplier. Costs for filtration of the bio-treatment process effluent are not included. The daily effluent waste load is estimated to be less than 0.2 kg (0.4 lb) for both COD and BOD.

Costs. The estimated incremental cost for this alternative is $146,000. Total costs are $219,000.

Reduction Benefits. Reduction of COD and BOD of more than 99.8 percent.

Vapor Absorption (Table 6)

Alternative A - No Waste Treatment or Control

Daily effluent waste load is estimated to be 410 kg (900 lb) of COD at a pH level above 9.5. The suspended solids waste load is negligible. Discharge is presently intermittent in this subcategory.

Costs. None.

Reduction Benefits. None.

Alternative B - Carbon Adsorption

This alternative involves treatment of the raw waste water in 2-stage granular activated carbon columns. The raw waste water is acidulated as necessary, but does not require filtration. The carbon is regenerated off-site by the supplier. The daily effluent waste load is estimated to be about 10 kg (22 lb) of COD with the pH value in the neutral range, 6 to 9.

Costs. Investment cost is estimated to be $130,000.

TABLE 6

TYPICAL PLANT
WATER EFFLUENT TREATMENT COSTS
ASBESTOS MANUFACTURING
VAPOR ABSORPTION

	(Costs in $1000)		
Treatment or Control Technologies:	A	B	C
Investment	-	130	152
Annual Costs:			
Capital Costs	-	10.4	12.2
Depreciation	-	9.3*	15.2**
Operating and Maintenance Costs (excluding energy and power costs)	-	8.7	1.8
Energy and Power Costs	-	1.0***	16.8
Total Annual Cost	-	29.4	46.0

Effluent Quality:

Effluent Constituents	Raw Waste Load	Resulting Effluent Levels		
COD - mg/l	1800	1800	50	Zero
Suspended Solids - mg/l	30	30	30	Zero
pH	>9	>9	6-9	-

* Expected lifetime - 14 years
** Expected lifetime - 10 years
*** Not including carbon regeneration

Reduction Benefits. Reduction of COD of approximately 98 percent and neutralization of alkali in effluent.

Alternative C - Zero Discharge

Zero discharge is achieved by replacement of the vapor absorption unit with a fume incinerator. No waste water is generated.

Costs. Estimated cost for this alternative is $152,000.

Reduction Benefits. Reduction of all pollutant constituents of 100 percent.

Wet Dust Collection (Tables 7, 8, and 9)

Alternative A - No Waste Treatment or Control

Estimated effluent waste load is 380 cu m (100,000 gal) per day of concentrated dust slurry. The dissolved solids level is not significantly higher than that of the carriage water.

Costs. None.

Reduction Benefits. None.

Alternative B - Sedimentation

This alternative comprises sedimentation, with coagulation as necessary, to remove suspended solids. Sludge is dewatered for disposal in a controlled sanitary landfill. Daily effluent waste load is estimated to be 11 kg (25 lb) of suspended solids. All known plants use this alternative as a minimum level of control.

Costs. Investment cost is estimated to be $64,000.

Reduction Benefits. Reduction of suspended solids of over 95 percent.

Alternative C - Zero Discharge

This alternative comprises substitution of dry dust collection devices (baghouses) for the wet dust scrubbers. No waste water is generated in using this control technology. Most of the friction materials plants now use such dry equipment.

Costs. Estimated investment cost is $94,000.

Reduction Benefits. Reduction of all pollutant constituents of 100 percent.

TABLE 7

TYPICAL PLANT
WATER EFFLUENT TREATMENT COSTS
ASBESTOS MANUFACTURING
WET DUST COLLECTION - SMALL PLANT

Treatment or Control Technologies:	(Costs in $1000) A	B	C
Investment	-	44	43
Annual Costs:			
Capital Costs	-	3.5	3.4
Depreciation	-	1.8*	1.7**
Operating and Maintenance Costs (excluding energy and power costs)	-	7.7	4.3
Energy and Power Costs	-	4.0	-
Total Annual Cost	-	17.0	9.4

Effluent Quality:

Effluent Constituents	Raw Waste Load	Resulting Effluent Levels		
COD (Filtrate) - mg/l	Unknown	Unknown	50	Zero
Suspended Solids - mg/l	Variable	Variable	30	Zero
pH	6-9	6-9	6-9	-

* Expected lifetime - 25 years
** Expected lifetime - 20 years

TABLE 8

TYPICAL PLANT
WATER EFFLUENT TREATMENT COSTS
ASBESTOS MANUFACTURING

WET DUST COLLECTION - MEDIUM PLANT

Treatment or Control Technologies:	(Costs in $1000) A	B	C
Investment	-	64	94
Annual Costs:			
Capital Costs	-	5.1	7.5
Depreciation	-	2.6*	4.7**
Operating and Maintenance Costs (excluding energy and power costs)	-	12.0	6.1
Energy and Power Costs	-	5.2	-
Total Annual Cost	-	24.9	18.3

Effluent Quality:

Effluent Constituents	Raw Waste Load	Resulting Effluent Levels		
COD (Filtrate) - mg/l	Unknown	Unknown	50	Zero
Suspended Solids - mg/l	Variable	Variable	30	Zero
pH	6-9	6-9	6-9	-

* Expected lifetime - 25 years
** Expected lifetime - 20 years

TABLE 9

TYPICAL PLANT
WATER EFFLUENT TREATMENT COSTS
ASBESTOS MANUFACTURING

WET DUST COLLECTION - LARGE PLANT

Treatment or Control Technologies:	(Costs in $1000) A	B	C
Investment	-	83	146
Annual Costs:			
Capital Costs	-	6.6	11.7
Depreciation	-	3.3*	7.3**
Operating and Maintenance Costs (excluding energy and power costs)	-	16.0	8.5
Energy and Power Costs	-	6.5	-
Total Annual Cost	-	32.7	27.5

Effluent Quality:

Effluent Constituents	Raw Waste Load	Resulting Effluent Levels		
COD (Filtrate) - mg/l	Unknown	Unknown	50	Zero
Suspended Solids - mg/l	Variable	Variable	30	Zero
pH	6-9	6-9	6-9	-

* Expected lifetime - 25 years
** Expected lifetime - 20 years

ENERGY REQUIREMENTS OF CONTROL TECHNOLOGIES

The energy required to incinerate the asbestos textile coating waste is estimated to be about 440 KW (590 hp) per daily batch of waste. (The textile coating waste is considered to have no heat value.) The energy requirements for the containment alternative are minimal and relate primarily to transportation of the containerized waste to a salvage facility or a sanitary landfill site.

The additional energy required in the solvent recovery category will also involve energy for transportation of waste sludge away from the plant and of activated carbon to and from the site if carbon columns must be employed for refractory wastes. The major energy requirements will be for pumping and aeration in the bio-treatment unit and for regeneration of the activated carbon columns. The former requirement is estimated to be about 7.5 kw (10 hp). The energy required to regenerate the carbon off-site at the supplier's facility cannot be estimated without knowing the scale of the operation. If it is large, the incremental energy required for this subcategory will not be significant because of the relatively small carbon requirements.

The energy requirements for implementation of the alternatives for the vapor absorption subcategory are primarily for fuel to regenerate the activated carbon and to operate the fume incinerator. The requirement for regeneration cannot be estimated for the same reason as with the solvent recovery subcategory, except that in this case, about ten times as much carbon is required per year because the waste is not pretreated by the biological process and also because no credit is taken for biological activity in the carbon columns. The energy requirements of the fume incinerator may be relatively high, but this unit will be operated only one or two days per month. The fuel requirement depends upon the energy content of the vaporized solvent.

The energy used in clarifying waste waters from wet dust collection is not large, 5 kw (6.7 hp) or less for the sludge removal mechanisms and no more than 20 kw (25 hp) for pumping. A centrifuge for dewatering the sludge would require 30 to 40 kw (40 to 53 hp) when running. The energy requirements for the operation of baghouses should be less than for wet dust collectors.

No information was provided by the industry relative to the energy requirements of individual manufacturing plants. Most of the friction materials plants use large amounts of energy for heating and curing their products. The additional energy required to implement the control and treatment technologies is estimated to be less than 10 percent of the requirements for the manufacturing and associated operations. The major potential energy uses are for textile coating waste incineration, carbon regeneration and fume incineration.

NON-WATER QUALITY ASPECTS OF CONTROL TECHNOLOGIES

Air Pollution

Three of the four subcategories in this industry relate totally or partially to control of pollutant emissions to the atmosphere. The use of the substituted dry control devices would effect equal, or better, control of the pollutants of interest. The only significant potential air pollution problem associated with the application of the control technologies at a typical plant is the release of materials from improperly managed solid residues. For example, exposed accumulations of dust from friction materials plants may serve as sources of air emissions.

There are no significant odor problems associated with implementation of the waste water control and treatment technologies. Neither are there any unusual or uncontrollable sources of noise associated with the control measures.

Solid Waste Disposal

The volumes of solid wastes resulting from application of the control technologies will not be large compared to many industries. The wastes do not present any unusual problems in handling or in disposal. A properly planned, designed, and operated sanitary landfill with capability for receiving industrial solid waste will be adequate. The disposal of dust is already practiced at all known friction materials plants and implementation of the control technologies will not create any unusual problems. Transportation of dust should be in closed vehicles or the dust should be heavily dampened to eliminate air emissions. The containerized waste from textile coating does not pose a health or environmental hazard if properly disposed of at a licensed landfill site.

There is no known recovery value in any of the residues from this industry with the possible exception of use as a fuel substitute. No data are available by which to evaluate this possibility.

For those waste materials considered to be non-hazardous where land disposal is the choice for disposal, practices similar to proper sanitary landfill technology may be followed. The principles set forth in the EPA's Land Disposal of Solid Wastes Guidelines (CFR Title 40, Chapter 1; Part 241) may be used as guidance for acceptable land disposal techniques.

For those waste materials considered to be hazardous, disposal will require special precautions. In order to ensure long-term protection of public health and the environment, special preparation and pretreatment may be required prior to disposal. If land disposal is to be practiced, these sites must not allow movement of pollutants such as fluoride and radium-226 to either ground or surface water. Sites should be selected that have natural soil and geological conditions to prevent such contamination or, if such conditions do not exist, artificial means (e.g., liners) must be provided to ensure long-term protection of the environment from hazardous materials. Where appropriate, the location of solid hazardous materials disposal sites should be permanently recorded in the appropriate office of the legal jurisdiction in which the site is located.

TABLE 10

EFFLUENT REDUCTION ATTAINABLE THROUGH APPLICATION OF BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE*

Subcategory	COD kg/kkg(lb/1000 lb) of finished asbestos product	Suspended Solids kg/kkg(lb/1000 lb) of finished asbestos product	pH
Solvent Recovery	0.150	0.090	6-9
Textile Coating	No discharge of process waste water pollutants		
Vapor Absorption	zero	zero	6-9
Wet Dust Collection	NA	0.090	6-9

*Maximum average of daily values for any period of 30 consecutive days.

SECTION IX

EFFLUENT REDUCTION ATTAINABLE THROUGH APPLICATION OF THE BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE EFFLUENT LIMITATIONS GUIDELINES

INTRODUCTION

The effluent limitations which must be achieved by July 1, 1977, are to specify the degree of effluent reduction attainable through the application of the Best Practicable Control Technology Currently Available. Best Practicable Control Technology Currently Available is generally based upon the average of the best existing performance by plants of various sizes, ages, and unit processes within the industrial category or subcategory. This average is not based upon a broad range of plants within an industry, but instead upon performance levels achieved by exemplary plants.

Consideration must also be given to:

a. The total costs of application of this control technology in relation to the effluent reduction benefits to be achieved from such application,

b. energy requirements,

c. non-water quality environmental impact,

d. the size and age of equipment and facilities involved,

e. the processes employed,

f. process changes, and

g. the engineering aspects of the application of this control technology.

Best Practicable Control Technology Currently Available emphasizes treatment facilities at the end of a manufacturing process, but also includes the control technologies within the process itself when the latter are considered to be normal practice within an industry.

A further consideration is the degree of economic and engineering reliability which must be established for the technology to be "currently available". As a result of demonstration projects, pilot plants, and general use, there must exist a high degree of confidence in the engineering and economic practicability of the technology at the time of commencement of construction or installation of the control facilities.

EFFLUENT REDUCTION ATTAINABLE THROUGH THE APPLICATION OF BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

Based on the information contained in Sections III through VIII of this document, it has been determined that the degrees of effluent reduction attainable through the application of the Best Pollution Control Technology Currently Available for this part of the asbestos manufacturing industry are those presented in Table 10. These values represent the maximum allowable average for any 30 consecutive calendar days. Maximum daily averages should not exceed twice the 30-day values.

Oxygen-Demanding Materials

Waste waters from the solvent recovery and vapor absorption subcategories normally contain significant quantities of dissolved organic materials that exert an oxygen demand. While some of these organic components are biodegradable, others are not. The BOD test is, therefore, of limited value, and the COD (or TOC) parameter is recommended. Application of control technology will reduce the concentrations of oxygen-demanding materials by at least 97 percent.

Suspended Solids

Suspended solids are the principal pollutant constituent in waste waters from the wet dust collection subcategory. Application of control technology will reduce the suspended solids to levels comparable to those achieved in the secondary treatment of municipal waste waters.

pH

The pH level of all waste waters should be in the neutral range from 6 to 9 upon application of this control technology.

IDENTIFICATION OF BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

The Best Practicable Control Technology Currently Available comprises in-plant measures for the textile coating subcategory and end-of-pipe treatment technologies for the solvent recovery, vapor absorption, and wet dust collection subcategories.

Textile Coating

The control technology comprises elimination of discharge by containment of dumped and spilled coating materials, dry techniques for cleaning of equipment and for housekeeping, and institution of water conservation practices to minimize the volume of waste. All wastes are containerized for salvage, use as a fuel substitute, or disposal in a controlled sanitary landfill, with or without prior incineration. Although this control technology is not practiced within this subcategory, it is believed to be much less costly than providing treatment to render the waste waters suitable for discharge to a surface water.

Solvent Recovery

The control technology comprises cooling of the waste water as necessary, adding supplemental nutrients, and treatment by the extended aeration version of the activated sludge process. The excess sludge is disposed of in a municipal sewage treatment plant. Although no plant in this subcategory presently uses this control technology, the available information on the raw waste waters indicates that they are amenable to biological treatment.

Vapor Absorption

For control technology in the vapor absorption subcategory, treatment with activated carbon was considered, with acid addition to lower the pH. The suspended solids level is negligible and prior filtration is not required. Because of the relatively small scale of the treatment units, the carbon would be regenerated off site, probably by the supplier. However, this control technology is not compatible with the Best Available Technology Economically Achievable, complete elimination of pollutants by means of fume incineration. Moreover, fume incineration is the current practice for much of the industry. For these reasons, fume incineration is considered to be the appropriate control technology.

Wet Dust Collection

For the wet dust collection subcategory, the control technology is sedimentation. Based on the available information, all plants in this subcategory now provide at least this level of control technology.

RATIONALE FOR THE SELECTION OF BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

Total Costs of Application

The total investment cost of implementing this control technology is estimated to be approximately $200,000. This figure is based on the known level of control presently provided in this industry and the fact that half of known effluent streams are discharged to municipal sewerage systems where the pollutant constituents are not known to be incompatible. If all plants in this part of the asbestos industry were to discharge directly to surface waters, the costs of implementing this technology is estimated to be $500,000. The total annual costs for all of the known manufacturing plants in the four subcategories are estimated to be $150,000.

Energy Requirements

The most significant energy requirement is fuel for fume incineration in the vapor absorption subcategory. Since there is only one known plant in this subcategory, the additional energy required is not large for the industry as a whole. Other energy requirements include those for possible incineration of the coating residues, pumping of the waste waters to the treatment facilities, for aeration of bio-treatment processes, and for transportation of wastes and activated carbon. All of these requirements will not increase the level of energy consumption at a typical plant by more than 5 percent.

Non-Water Quality Environmental Impact

There is no evidence that application of BPCTCA control technology will result in any unusual air pollution, noise, radiation, or solid waste management problems, either in kind or magnitude. The costs of avoiding problems in these areas are not excessive. The principal area for attention is the disposal of solid wastes; sludges, slurries, and other residues.

Size and Age of Equipment and Facilities

Differences in size and age of the manufacturing equipment and facilities do not influence the applicability of this control technology.

Processes Employed

There is no information available to indicate that the control technology cannot be applied to some plants because of the processes employed. However, each plant is unique, and an individual evaluation is required at each location to determine the suitability of the control technology and define any necessary modifications.

Process Changes

No changes in the manufacturing processes are required to implement this control technology. There are no anticipated changes in production methods in any of the four subcategories that would lessen the effectiveness of the control technology. Solvent changes can be compensated for by over-design of the carbon units or by changes in their operation.

Engineering Aspects of Application

Outside of sedimentation in the wet dust collection subcategory and fume incineration in the vapor absorption subcategory, this level of control has not been applied in this industry. The recommended in-plant control measures and end-of-pipe treatment technologies have been widely applied in other industrial settings, however, and no technical difficulties are anticipated. As noted elsewhere, the data base for this document is not extensive, and evaluation of each plant's particular wastes is necessary before implementing any control measure. Of particular interest would be the biodegradability of waste waters from solvent recovery facilities. The need for coagulation should be evaluated for the waste waters from wet dust collectors.

TABLE 11

EFFLUENT REDUCTION ATTAINABLE THROUGH APPLICATION OF BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE*

Subcategory	COD kg/kkg(lb/1000 lb) of finished asbestos product	Suspended Solids kg/kkg(lb/1000 lb) of finished asbestos product	pH
Solvent Recovery	0.150	0.090	6-9
Textile Coating	No discharge of process waste water pollutants		
Vapor Absorption**	No discharge of process waste water pollutants		
Wet Dust Collection**	No discharge of process waste water pollutants		

*Maximum average of daily values for any period of 30 consecutive days.

**Vapor absorption and west dust collection can be replaced by non-water contact technologies - see text.

SECTION X

EFFLUENT REDUCTION ATTAINABLE THROUGH APPLICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE EFFLUENT LIMITATIONS GUIDELINES

INTRODUCTION

The effluent limitations that must be achieved July 1, 1983, are to specify the degree of effluent reduction attainable through the application of the Best Available Technology Economically Achievable. This control technology is not based upon an average of the best performance within an industrial category, but is determined by identifying the very best control and treatment technology employed by a specific plant within the industrial category or subcategory, or that is readily transferable from one industry to another:

Consideration must also be given to:

a. The total cost of application of this control technology in relation to the effluent reduction benefits to be achieved from such application,
b. energy requirements,
c. non-water quality environmental impact,
d. the size and age of equipment and facilities involved,
e. the processes employed,
f. process changes, and
g. the engineering aspects of the application of this control technology.

The Best Available Technology Economically Achievable also considers the availability of in-process controls as well as in-plant control measures and additional end-of-pipe treatment techniques. This control technology is the highest degree that has been achieved or has been demonstrated to be capable of being designed for plant scale operation up to and including "no discharge" of pollutants.

Although economic factors are considered in this development, the costs for this level of control are intended to be the top-of-the-line of current technology subject to limitations imposed by economic and engineering feasibility. However, this control technology may be characterized by some technical risk with respect to performance and with respect to certainty of costs. Therefore, the control technology may necessitate some industrially sponsored development work prior to its application.

EFFLUENT REDUCTION ATTAINABLE THROUGH APPLICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

Based upon the information contained in Sections III through VIII of this document, a determination has been made that the degrees of effluent reduction attainable through the application of the Best

Available Technology Economically Achievable are those listed in Table 11. The values given for the solvent recovery subcategory are the maximum allowable averages for 30 consecutive days. Maximum daily values should not exceed two times the 30-day averages.

Oxygen-Demanding Materials

Application of BATEA control technology will reduce the concentration of oxygen-demanding materials in the raw waste waters from the solvent recovery subcategory by at least 97 percent.

Suspended Solids

The suspended solids in the raw waste waters from solvent recovery facilities, consisting of biological solids generated in waste treatment, remain the same as those for BPCTCA, but suspended solids from dust collection are eliminated.

pH

The waste waters discharged following application of this control technology will have pH values in the neutral range of 6 to 9.

IDENTIFICATION OF BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

The Best Available Technology Economically Achievable comprises the installation of advanced end-of-pipe treatment technology in the solvent recovery subcategory and substitution of a different type of in-plant air pollution control equipment in the wet dust collection subcategory.

Textile Coating

The control technology for the textile coating subcategory is the same as the Best Practicable Technology Currently Available as presented in Section IX. No additional control is required.

Solvent Recovery

The control technology is the same as the Best Practicable Control Technology Currently Available presented in Section IX.

Vapor Absorption

No discharge of process wastes is achieved in this subcategory by replacement of vapor absorption systems with fume incinerators.

Wet Dust Collection

The control technology for the wet dust collection subcategory is replacement of the wet scrubbers with baghouses or other dry particulate collection devices of equal efficiency. No waste water is generated with this control technology.

RATIONALE FOR THE SELECTION OF BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

Total Costs of Application

If all known manufacturing plants in this part of the asbestos manufacturing industry implemented this control technology in order to reduce or eliminate the discharge of pollutants to surface waters, the estimated cost would be $600,000 in addition to the amount spent to implement the Best Practicable Technology Currently Available. The additional annual costs for all known plants would be about $150,000. Since some plants can be expected to continue to discharge to municipal sewerage systems, the actual investment cost for this control technology is estimated to be closer to $450,000. The actual combined cost for implementation of both levels of control technologies is estimated to be about $675,000, with the total annual costs estimated to be about $200,000 for the industry.

Energy Requirements

Application of this control technology will result in a minor reduction in energy requirements through replacement of wet scrubbers with dry dust collection systems.

Non-Water Quality Environmental Impact

The application of the Best Available Technology Economically Achievable should not create any new air or land pollution problems. The replacement of wet air pollution control equipment in this control technology should, in fact, result in lower emissions of pollutants to the atmosphere, since in this industry baghouses have been found to be slightly more effective than wet scrubbers for the removal of particulates produced in friction materials manufacturing plants.

Size and Age of Equipment and Facilities

Differences in size and age of the manufacturing equipment and facilities do not influence the applicability of this control technology.

Processes Employed

Since this control technology is entirely related to auxiliary operations and not to the manufacturing processes, it can be applied without particular regard to the processes employed.

Process Changes

For the reason noted in the previous paragraph, application of this control technology does not require any changes in any of the manufacturing processes in any subcategory of this industry. Any normal process changes would not lessen the effectiveness of the control technology. If different solvents are used, the operation of the fume incinerator and the activated carbon units can be modified to compensate for the changes.

Engineering Aspects of Application

Although no insurmountable problems are anticipated in applying this control technology, an engineering evaluation will be necessary prior to implementation in each plant in the solvent recovery subcategory. If carbon adsorption should not be effective, more sophisticated processes, e.g., reverse osmosis, might be necessary to meet the recommended effluent limitations. In the design of a fume incinerator, the engineer must consider the auxiliary energy requirement, if any, and any potential for production of toxic by-products. Application of the recommended control technology in the wet dust collection subcategory has already been widely demonstrated and no unusual engineering problems should arise.

SECTION XI

NEW SOURCE PERFORMANCE STANDARDS

INTRODUCTION

Defined standards of performance are to be achieved by new sources of waste waters. The term "new source" is defined to mean "any source, the construction of which is commenced after the publication of proposed regulations prescribing a standard of performance."

In defining performance standards for new sources, consideration must be given to:

a. Costs and energy requirements,
b. Non-water quality environmental impact, and
c. Process and other operational changes.

EFFLUENT QUALITY ACHIEVED THROUGH IMPLEMENTATION OF NEW SOURCE PERFORMANCE STANDARDS

Implementation of New Source Performance Standards will result in the recommended effluent qualities given in Table 12. The values for the solvent recovery subcategory are the maximum allowable averages for 30 consecutive days. Maximum daily values should not exceed twice the 30-day averages.

Pollutant Constituents

Implementation of the new source performance standards in the solvent recovery subcategory should reduce all pollutant constituents to levels comparable to secondary treatment of municipal sewage.

IDENTIFICATION OF NEW SOURCE PERFORMANCE STANDARDS

In the design and operation of new manufacturing facilities, inplant controls and end-of-pipe technology will be required to meet the recommended standards.

Textile Coating

New sources in the textile coating subcategory should be designed and built to contain all wastes. Such design and operation will involve minimal additional construction costs and only moderate annual costs. It is recommended that the collected textile coating waste be disposed to a sanitary landfill, with or without incineration, as appropriate. If incineration must be employed, emissions will consist primarily of water vapor and carbon dioxide and should not create air pollution problems. Initially, consideration should be given to recovery and reuse of the coating material instead of incineration or land disposal.

TABLE 12

STANDARDS OF PERFORMANCE FOR NEW SOURCES*

Subcategory	COD kg/kkg(lb/1000 lb) of finished asbestos product	Suspended Solids kg/kkg(lb/1000 lb) of finished asbestos product	pH
Solvent Recovery	0.150	0.090	6-9
Textile Coating	No discharge of process waste water pollutants		
Vapor Absorption**	No discharge of process waste water pollutants		
Wet Dust Collection**	No discharge of process waste water pollutants		

*Maximum average of daily values for any period of 30 consecutive days.

**Vapor absorption and west dust collection can be replaced by non-water contact technologies - see text.

Solvent Recovery

The use of biological treatment is recommended to meet the new source performance standards in the solvent recovery subcategory. This end-of-pipe technology may require cooling and addition of supplemental nutrients, but is generally the least costly means of reducing the organic concentrations in the waste water. If due to presence of refractory organic materials this method is not feasible, carbon adsorption, reverse osmosis, or other advanced treatment technology may be used. The energy requirements are small for bio-treatment, but increase for the more advanced processes. Solvent recovery provides a means of conserving material resources and eliminating air pollution. The benefits derived must be balanced against the increased use of energy resources.

Vapor Absorption

It is recommended that vapor or fume emissions in all new sources be either recovered for reuse or as fuel substitutes or be removed from the exhaust air stream by means other than absorption in water. Several alternative technologies that do not generate waste waters are available. The costs and energy requirements for alternatives such as fume incineration will probably be slightly higher than for a wet scrubber.

Wet Dust Collection

It is recommended that dust, or particulate, emissions in all new sources be controlled by baghouses or other, equally effective, dry collection devices. These have proven to be somewhat more effective than wet scrubbers in this industry, and no waste water is generated. The costs and energy requirements are comparable to wet collection. The use of dry devices does not create any unusual non-water quality environmental problems.

Dispersion Process

As noted in Sections IV and V of this document, an additional subcategory may be created if the dispersion process for making asbestos yarn becomes operational in this industry. This process is now in the developmental stages in two plants in the country and it is known that waste waters are generated. The scale of operations are too limited to permit definition of the possible control technologies and standards of performance for these potential new sources. It can be predicted, however, that in-plant control measures to conserve water and materials as well as end-of-pipe treatment technology to reduce the organic load; suspended solids, and, possibly, heavy metals, hexane extractables, and plant nutrients will be required. The effluent limitations and the feasibility of "no discharge" of pollutants will have to be determined in the future.

SECTION XII

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SECTION XIII

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SECTION XIV

GLOSSARY

Those terms in this document that have special definitions within the asbestos manufacturing industry or the water pollution control field are presented here for the convenience of the reader. Technical terms not included here are explained in standard dictionaries.

1. "Act" - The Federal Water Pollution Control Act Amendments of 1972.

2. Absorption - the process of taking up or assimilating a gas or a liquid, specifically, the solution of a vapor in water.

3. Adsorption - the adhesion in an extremely thin layer of molecules to the surfaces of solid bodies, specifically activated carbon particles.

4. Asbestos - not a distinct mineral species, but a commercial term applied to fibrous varieties of several minerals differing widely in chemical composition and in fiber length, strength, and flexibility. Varieties include:

   Chrysolite - a hydrated magnesium silicate that is the most abundant and the most important of the commercial mineral fibers.

   Crocidolite - a complex silicate of iron, magnesium, and sodium that is especially resistant to acid attack.

   Amosite - a ferrous silicate in which some of the iron is replaced by magnesium. It is the longest of all asbestos fibers and is more resistant to heat than the two varieties above.

5. Baghouse - a structure housing tubular or envelope-shaped bags that filter dust and particulate matter from an air stream.

6. Category and Subcategory - divisions of a particular industry possessing different traits that affect waste water characteristics and treatability.

7. Coating - the application of various finishing materials to textiles to improve their properties and/or to minimize air emissions during fabrication and use.

8. Chemical Oxygen Demand (COD) - an indirect measure of the organic material present in a water sample. Most organic compounds are measured in this analysis.

9. Dissolved Solids - the amount of material remaining after a

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filtered water sample is evaporated to dryness at 103°C.

10. Doctor Blade - a sharp blade for wiping excess material from a surface.

11. Dust Scrubber - a device for removing particulate matter from an air stream by collecting it in water.

12. Friction Materials - a group of products including brake linings, brake blocks, clutch facings, and related items.

13. Fume Incinerator - an air pollution control device that thermally oxidizes combustible aerosols, gases, or vapors, sometimes termed an afterburner.

14. Fume Scrubber - an air pollution control device that removes pollutant constituents from an air stream by dissolving them in a liquid solvent, specifically water.

15. Hexane Extractables - materials in a water sample that respond to analytical procedures designed to measure grease, oil, and similar materials.

16. MBAS - abbreviation for Methylene Blue Active Substances. These are the anionic surfactants, or synthetic detergents.

17. New Source - any source of waste water, the construction of which is commenced after publication of the proposed regulations prescribing a standard of performance.

18. Organic Materials - carbon-containing compounds manufactured in the life processes of plants and animals, or synthetically. They can be oxidized to carbon dioxide, water, and other simple inorganic compounds.

19. pH - a measure of the relative acidity or basicity of a water.

36. "Water Quality Criteria 1972," National Academy of Sciences and National Academy of Engineering for the Environmental Protection Agency, Washington, D.C. 1972 (U.S. Government Printing Office Stock No. 5501-00520).

20. Sealing Devices - gaskets, packings, seals, washers, and similar items, specifically those that contain asbestos.

21. Suspended Solids - non-filterable solids in a water sample, i.e., those materials not in solution.

22. Textiles - specifically asbestos yarn, cord, rope, thread, tape, wick, cloth, and non-woven felts.

23. Total Organic Carbon (TOC) - the result of a high temperature catalytic oxidation procedure for measuring organic materials in water.

TABLE 13

METRIC TABLE

CONVERSION TABLE

MULTIPLY (ENGLISH UNITS) by TO OBTAIN (METRIC UNITS)

ENGLISH UNIT	ABBREVIATION	CONVERSION	ABBREVIATION	METRIC UNIT
acre	ac	0.405	ha	hectares
acre - feet	ac ft	1233.5	cu m	cubic meters
British Thermal Unit	BTU	0.252	kg cal	kilogram - calories
British Thermal Unit/pound	BTU/lb	0.555	kg cal/kg	kilogram calories/kilogram
cubic feet/minute	cfm	0.028	cu m/min	cubic meters/minute
cubic feet/second	cfs	1.7	cu m/min	cubic meters/minute
cubic feet	cu ft	0.028	cu m	cubic meters
cubic feet	cu ft	28.32	l	liters
cubic inches	cu in	16.39	cu cm	cubic centimeters
degree Fahrenheit	°F	0.555(°F-32)*	°C	degree Centigrade
feet	ft	0.3048	m	meters
gallon	gal	3.785	l	liters
gallon/minute	gpm	0.0631	l/sec	liters/second
horsepower	hp	0.7457	kw	killowatts
inches	in	2.54	cm	centimeters
inches of mercury	in Hg	0.03342	atm	atmospheres
pounds	lb	0.454	kg	kilograms
million gallons/day	mgd	3,785	cu m/day	cubic meters/day
mile	mi	1.609	km	kilometer
pound/square inch (gauge)	psig	(0.06805 psig +1)*	atm	atmospheres (absolute)
square feet	sq ft	0.0929	sq m	square meters
square inches	sq in	6.452	sq cm	square centimeters
ton (short)	ton	0.907	kkg	metric ton (1000 kilograms)
yard	yd	0.9144	m	meter

* Actual conversion, not a multiplier

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